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An Ecological Land Survey for Fort Greely, Alaska

M. Torre Jorgenson, Joanna E. Roth, Michael D. Smith, Sharon Schlentner, Will Lentz, Erik R. Pullman, and Charles H. Racine

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Charles H. Racine

February 2001

Prepared for
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PREFACE

This report was prepared by M. Torre Jorgenson, Senior Scientist, Joanna E. Roth, Research Biologist, Michael D. Smith, Systems Analyst, Sharon Schlentner, Will Lentz, GIS Technicians, and Erik R. Pullman, ABR, Inc., Fairbanks, Alaska, and Charles H. Racine, Ecologist, U.S. Army Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory (CRREL), Hanover, New Hampshire.

Technical review was provided by Robert W. Lichvar and Lawrence Gatto, both of CRREL, and Stephen Murphy and Susan Bishop (ABR, Inc.).

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CONTENTS

ILLUSTRATIONS

TABLES

Table

An Ecological Land Survey for Fort Greely, Alaska

M. TORRE JORGENSON, JOANNA E. ROTH, MICHAEL D. SMITH,
SHARON SCHLENTNER, WILL LENTZ, ERIK R. PULLMAN, AND CHARLES H. RACINE

INTRODUCTION

In response to the need for information on the natural resources of Fort Greely, we conducted an ecological land survey (ELS) within the base's boundaries. This information is needed for ongoing resource management on the base, including assessing potential environmental impacts associated with withdrawal of public lands for military use (CEMML 1998) and the Integrated Training Area Management program being implemented by the U.S. Army. Accordingly, this report presents the rationale and methods used to classify and map ecosystems on the base, describes the nature and dynamics of these ecosystems, and documents the structure of the GIS databases used in mapping and aggregating ecosystems at several spatial scales.

Spatial databases developed from an ecological land classification are essential to managing land resources and have many uses, such as assessing ecological risks, analyzing terrain sensitivity and wildlife habitats, mitigating wetland damage, planning for training exercises, locating facilities, identifying rare habitats, and managing fire. By delineating areas with co-varying climate, geomorphology (surficial geology, terrain units), surface-forms, hydrology, and biota, the resulting maps provide a stratified view that is particularly useful for integrated resource management based on GIS. This hierarchy of scales can help land managers and military trainers access information, identify information gaps, and improve resource management of large areas.

Ecological land survey approach

In an ELS, landscapes are viewed not just as aggregations of separate biological and earth resources, but as ecological systems with functionally related parts (Rowe 1961; Wiken and Ironside 1977; Bailey 1980, 1996; Driscoll et al. 1984). The goal of an ELS, then, is to provide a consistent conceptual framework for modeling, analyzing, interpreting, and applying ecological knowledge. To provide the information required for such a wide range of applications, an ELS involves three types of efforts:

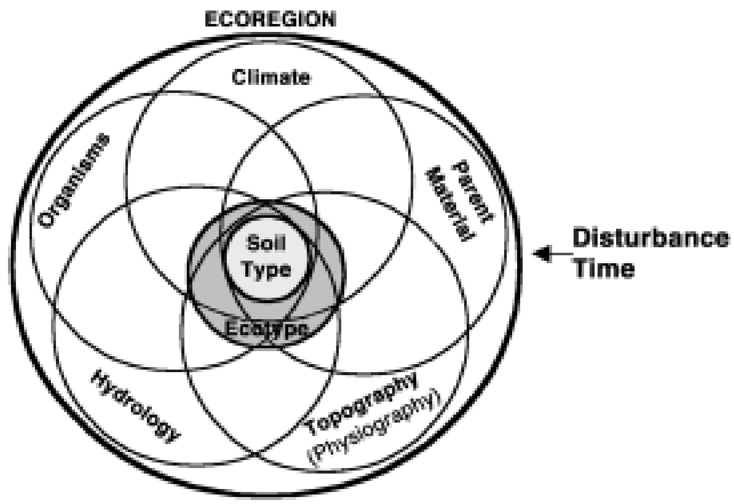
- An ecological land survey that inventories and analyzes data obtained in the field.
- An ecological land classification that classifies and maps ecosystem distribution.
- An ecological land evaluation that assesses the capabilities of the land for various land management practices.

Our emphasis in this report is on the ecological land survey and classification efforts. A companion report examines some of the potential land evaluation applications, such as permafrost distribution and sensitivity, disturbance regimes, and wildlife habitat use (Jorgenson et al., in prep.).

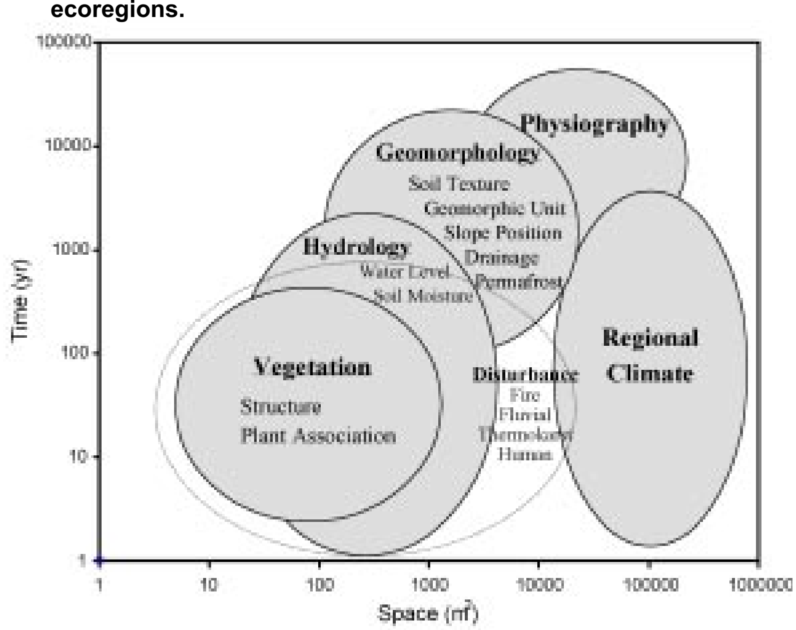
The structure and function of ecosystems largely are regulated along energy, moisture, nutrient, and disturbance gradients and these gradients are affected by climate, physiography, soils, hydrology, flora, and fauna, which can be viewed as ecosystem components or "state factors" (Barnes et al. 1982, ECOMAP 1993, Bailey 1996). Accordingly, we used the state factor approach (Jenny 1941, Van Cleve et al. 1990, Vitousek 1994, Bailey 1996, Ellert et al. 1997) to partition the variations in independent factors, or ecosystem components (e.g., climate, organisms, topography, parent material, and time), and to help us classify and map ecosystems (Fig. 1a). While thematic maps of individual ecosystem components (e.g., geomorphology and vegetation) have their particular uses, this linking and aggregating of components into ecosystems with co-varying climate, geomorphology, surface-forms, hydrology, and biota can provide a stratified view that conveys a much

broader range of information required for ecosystem management.

An ecological land classification also requires that ecosystem components be organized at various scales (Wilken 1981, O'Neil et al. 1986, Klijn and Udo de Haes 1994, Bailey 1996) on the basis of recognizing that the state factors operate within a hierarchy of differing spatial and temporal scales (Allen and Starr 1982, Delcourt and Delcourt 1988, Forman 1995). This hierarchical linkage reveals that smaller scale features, such as vegetation, are nested within larger scale components, such as climate or physiography (Fig. 1b). The climate factor, particularly temperature and precipitation, accounts for the largest amount of variation in ecosystem structure and function globally (Walter 1979, Vitousek 1994, Bailey 1998). Physiography, or broad-scale landforms, with a characteristic geologic substrate, surface shape, and relief are the boundary conditions that control the spatial arrangement and rate of geomorphic processes and thus affect the material (characteristic lithologies or soil texture) and energy flows, which in turn affect ecosystem development (Wahrhaftig 1965,



a. Ecotypes are local-scale ecosystems composed of various elements that exist within large regional ecosystems, or ecoregions.



b. Factors affecting ecosystem distribution occur over a range of scales within a nested hierarchy.

Figure 1. Interaction of interrelated state factors that control structure and function of ecosystems.

Swanson et al. 1988, Bailey 1996). Soil moisture and hydrologic movement are critical factors in the water balance of plants and the availability of nutrients (Fitter and Hay 1987, Oberbauer et al. 1989). Vegetation typically is the most important factor controlling the trophic structure of ecosystems, because it controls primary productivity, affects material and energy exchanges, provides structure and energy for other trophic levels, and affects soil erosion and geomorphic processes (Walter 1979, Bailey 1996). For biotic classifications, vegetation has an advantage over faunal components because plants are relatively immobile and therefore easier to characterize and map (Brown et al. 1998). Natural and human disturbances have long been recognized as important factors affecting the timing and development of ecosystems (Watt 1947, Pickett et al. 1989, Forman 1995).

Beyond this conceptual framework of state factor control, however, there is no single natural scale at which ecological phenomena should be studied. This leads observers to impose their own perceptual bias in the study of the patterns and processes of ecological phenomena (Levin 1992, Shugart 1998). In addition, there is no nationally accepted approach to classifying ecosystems, although recent efforts have been made to develop a consensus among Federal agencies (ECOMAP 1993) and among nations (Klijn and Udo de Haes 1994, Uhling and Jordan 1996). In this report, we generally have followed the scales and differentiating criteria described by Klijn and Udo de Haes (1994), which combine elements of both the Canadian (Wiken and Ironside 1977) and U.S. systems (ECOMAP 1993). Our system uses numerous spatial scales for mapping ecosystems and identifies various ecosystem components as the prime criteria for differentiating successive levels of hierarchical organization.

In Alaska, a hierarchical approach to vegetation and land cover mapping has been developed for northern Alaska by Walker and his colleagues (Walker 1983, Walker et al. 1989, Walker and Walker 1991). They also applied an integrated, geobotanical approach to mapping ecosystem components in the Prudhoe Bay region, but they did not create a hierarchy of integrated units (Walker et al. 1980). Recently, an integrated-terrain unit approach has been used for large-scale mapping of ecosystems on the Arctic Coastal Plain (Jorgenson et al. 1997) and in interior Alaska (Jorgenson et al. 1999), and for mapping vegetation complexes across the entire North Slope (Walker 1997). Land cover mapping also has been done for Tanana Valley and adjacent Alaska Range by the Bureau of Land Management (USBLM 1997).

Fort Greely ecological land survey

In this report, we evaluate and present three levels of ecosystem organization, ecotypes (1:50,000 scale), ecosections (1:100,000), and ecodistricts (1:500,000). Ecotypes (also called local ecosystems, ecotopes, landtype phases, or vegetation types) delineate areas with homogenous topography, terrain, soil, surface-form, hydrology, and vegetation. Ecosections (also landscapes, landtype associations, or geomorphic sections) are homogeneous with respect to geomorphic features and have recurring patterns of water regimes, soils, and vegetation. Although several vegetation classes can be included in an ecosection, the vegetation classes usually are related because they occur as different stages in a successional sequence. Ecodistricts (or subregions, physiographic districts) are broader areas with similar geology, geomorphology, and hydrology. Ecoregions (or climatic zones), which differentiate areas based on their climatic regimes and gross physiography, have been mapped recently for Alaska by Gallant et al. (1995), although their criteria differed slightly from those mentioned above.

The spatial databases produced by this project are being incorporated into numerous studies. Associations between ecotypes and wetland status will be used to delineate jurisdictional wetlands (Lichvar and Sprecher, in prep.). The mapping has been used to stratify field sampling and to analyze habitat use (Anderson et al. 1999). Other applications include analysis of permafrost occurrence and degradation, and stratification of monitoring locations for the Land Condition and Trends Analysis program.*

Study area

Fort Greely is located near Delta Junction in central Alaska and covers approximately 267,636 ha (661,341 acres) of land (Fig. 2). Included within Fort Greely are the West Training Area (231,479 ha between the Richardson Highway and Little Delta River), the East Training Area (20,879 ha between the Richardson Highway and Granite Creek), and the Main Post. Three outlying training areas, the Gerstle River Test Site, Black Rapids Training Area, and the Whistler Creek Rock Climbing Area, were not included in this ELS; thus, our study area for mapping covered 260234 ha.

Fort Greely originated as Station 17, Alaska Wing of the Air Transport Command, in 1942 to serve as a refueling stop and was reduced to inactive status in 1945 (CEMML 1998). In 1948, the installation was reacti-

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*Personal communication with Cal Bagley, Center for Ecological Management of Military Lands, Fort Collins, Colorado, 1999.

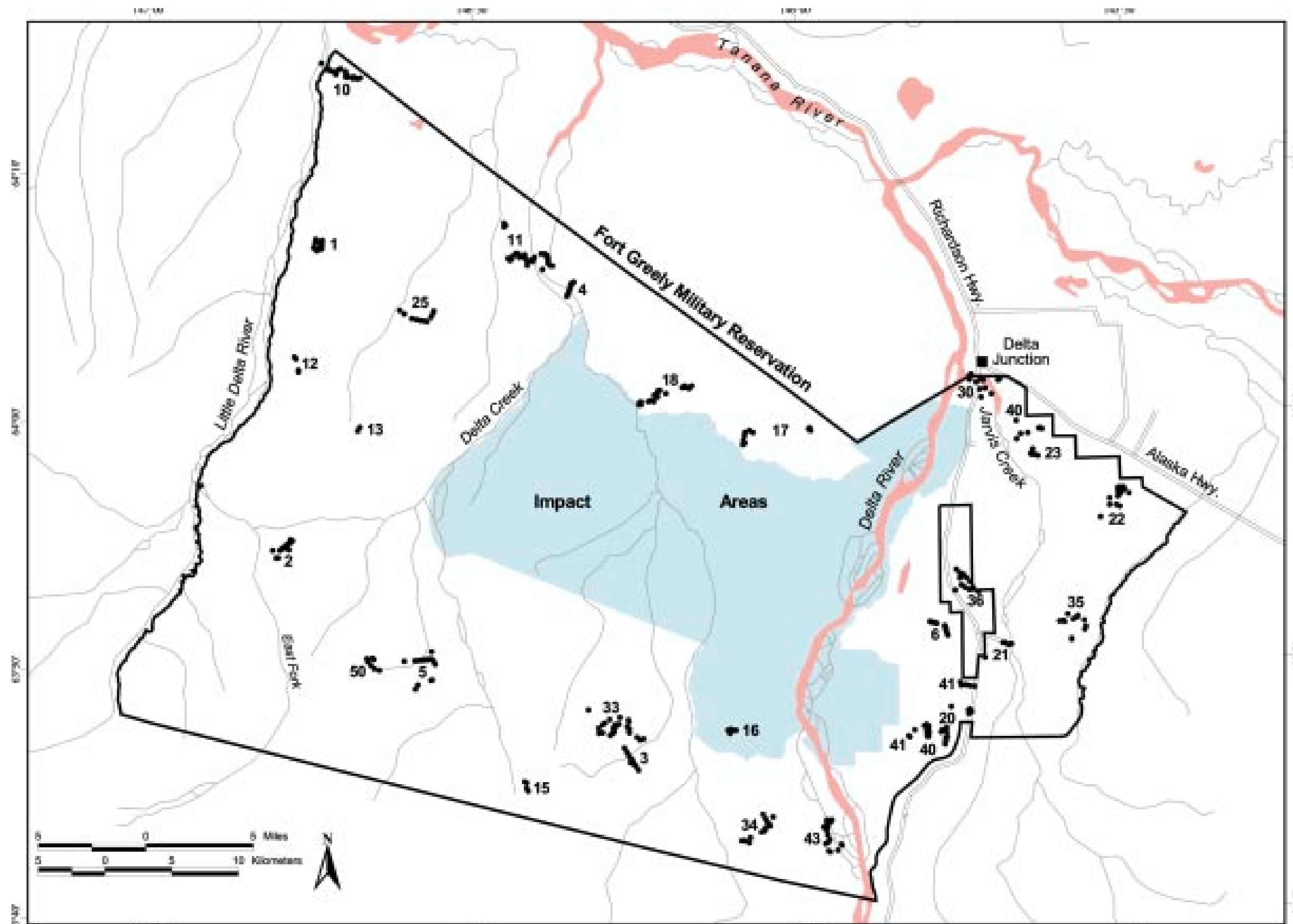


Figure 2. Location of study area and survey transects for the ecological land survey for Fort Greely.

vated for cold weather maneuvers and named the Arctic Training Center in 1949. Designations and purposes changed throughout the 1950–1990's, but activities mostly focused on cold weather training. Most of the facilities were constructed during the 1950's, including the military's first nuclear power plant. Chemical and biological weapons were tested during the 1950's. Under the *Base Realignment and Closure Act of 1995*, Congress designated a portion of the Main Post to be closed and training activities were to be realigned with Fort Wainwright. Fort Greely currently is used for artillery and mortar firing, aerial gunnery, small arms firing, platoon to brigade exercises, and bivouacs because of the large area and the unique opportunities for cold weather testing, glacier training, mountaineering, river rafting, and ice-bridge construction. The U.S. Air Force is a major user of Fort Greely and has designated the Oklahoma/Delta Creek Impact Areas as the primary sites for military aircraft training.

The continental climate of interior Alaska has extreme annual temperature variations and low precipitation. Light surface winds are typical over most of the region, though mountain passes, including the Fort Greely area, can experience strong, gusty winds. According to U.S. Weather Bureau records (1937–1998), the mean annual temperature is –2.3°C, with extremes ranging from –51 to 38°C (Fig. 3). The mean monthly temperature is 15.6°C for July and –19.9°C for January. The average annual precipitation is 297 mm and annual snowfall averages 178 cm. Most precipitation falls during June and July.

The bedrock geology of interior Alaska is dominated by Precambrian micaceous schist of the Birch Creek formation, but also includes metamorphic, sedimentary, and volcanic rocks of Paleozoic age (Péwé et al. 1966, Wilson et al. 1998). Upland areas adjacent to the Delta River usually are covered with Pleistocene loess deposits varying from a few centimeters on hilltops to over 14 m in low-lying areas. Some loess has been retransported from hills to the valley bottoms where it forms deposits of laminar to massive silt rich in organic debris (Péwé 1975, Péwé and Reger 1983). Glaciofluvial sediments both from the Delta creek glaciations and modern glaciers are evident throughout the study area (Holmes and Benninghoff 1957, Péwé et al. 1966, Péwé 1975, Péwé and Reger 1983). Moraines from the Delta and Donnelly glaciations form prominent deposits in the valleys (Péwé and Holmes 1964, Péwé and Reger 1983, Ten Brink 1983).

Soils of the study area tend to be poorly developed Inceptisols, undeveloped Entisols, or Histosols (Rieger et al. 1979). Ochrepts (well-drained Inceptisols that have only small amounts of organic matter at the surface) occur on hills where permafrost generally is absent. Aquepts (wet Inceptisols with thin to thick layers of poorly decomposed organic matter) are found in poorly drained areas and are commonly associated with ice-rich permafrost. Aquents or Fluvents (wet mineral Entisols associated with shallow or deep water tables) occur on floodplains and seepage areas. Histol soils, such as Fibrists (deep organic soils made up mostly of undecomposed sedges or mosses), are seen in depressions or wet areas in which the soil is saturated for long periods. Permafrost may or may not be present in these organic soils. Overall, permafrost tends to occur on north-facing slopes and valley bottoms and is absent on south-facing slopes, in coarse-grained sediments, and in areas of groundwater movement (Viereck et al. 1986, Williams 1970).

Within interior Alaska, the interrelationships among geomorphology, slope, aspect, hydrology, permafrost, and fire result in a complex pattern of vegetation types

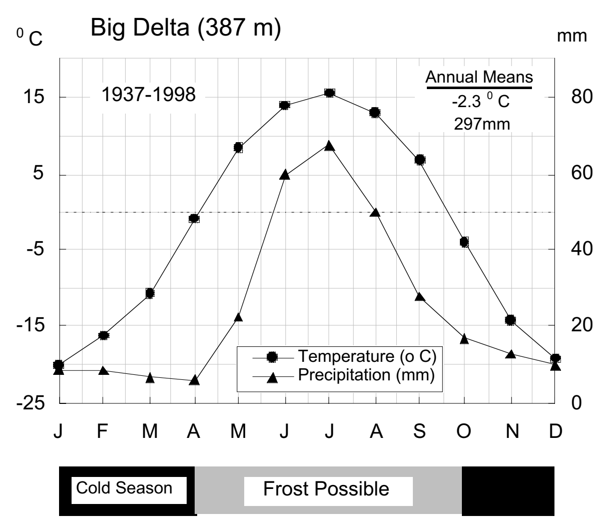


Figure 3. Climate at the Big Delta station near Fort Greely (mean monthly temperature and precipitation).

(Johnson and Vogel 1966; Nieland 1975; Van Cleve et al. 1983, 1986; Van Cleve and Viereck 1983; Viereck et al. 1983, 1993). Taiga ecosystems are dominated by open, slow growing spruce interspersed with occasionally dense, well-developed forest stands and treeless bogs. On the warmest, well-drained sites, the forests consist of closed spruce-hardwood stands: white spruce (*Picea glauca*), paper birch (*Betula papyrifera*), and quaking aspen (*Populus tremuloides*). Productive forests of balsam poplar (*Populus balsamifera*) and white spruce form along floodplains. On poorly drained sites, including those underlain by permafrost and on north-facing slopes, the dominant forest species is black spruce (*Picea mariana*). Bogs vary from rich sedge types to oligotrophic sphagnum bogs. Sedge-tussock meadows, with co-dominant low and dwarf shrubs, are prevalent.

METHODS

Field survey

Field sampling in 1996 and 1998 was done according to two different sampling designs. Initially, in September 1996, we sampled 74 ground-reference plots (approximately 100 m^2) on seven transects (toposequences) using a gradient-directed sampling scheme (Austin and Heyligers 1989). This design optimized the likelihood of sampling the complete range of ecological conditions and provided the spatial relationships necessary for interpreting ecosystem development. Transect locations were stratified using the ecodistrict map to allocate the sampling to a range of physiographic conditions. An additional 89 ground-reference plots were sampled subjectively in sites not represented along the transects. In August 1998, we used a preliminary unsupervised spectral classification of the Landsat image (see the *Mapping* section) to stratify sampling of 126 less intensive verification plots. In addition, 89 more-intensive ground-reference plots were established to sample ecotypes that were under-represented in 1996. This sampling system was designed to over-sample rare types and under-sample common types. Data from the ground-reference plots were used for classifying ecosystems, identifying ecological relationships, and mapping. Data from the map verification plots were used only for mapping.

The seven toposequences in the various ecodistricts were selected to cross the dominant geomorphic units in the study area: fluvial deposits (glaciofluvial outwash and other floodplains), glacial deposits (young and old moraines), lowland eolian and retransported materials (lower slopes), upland slopes, and alpine tundra. Transects were located in areas that maximized the range of possible vegetation types over a short distance (about 1 km). Ground-reference plots for ecosystem descriptions (8–12 per transect) were located in distinct vegetation types or spectral signatures identifiable on aerial photographs. At each plot, we gave a basic descriptions of geology, hydrology, near-surface soil stratigraphy, permafrost occurrence, and vegetation. Plots were located on aerial photography and coordinates were obtained with a GPS. Field data sheets and photos are archived at ABR, Inc.

Topographic profiles for each transect were obtained by measuring relative elevations at topographic breaks along the length of the transects. Measurements were made with an auto-level and rod or with a total station. Because the transects were in remote locations, approximate datums were obtained from the USGS maps. At each sampling station, notations were made describing surface-form and microrelief.

Hydrological observations included classification of the origin of water, water depth, depth to saturated soil when water was not present in soil sampling pit, pH, electrical conductivity (EC), and temperature. Water quality measurements were made with Oakton or Cole-Palmer pocket meters calibrated to standards within the range of use at regular intervals in the field. When water was not present, pH and EC were determined in a saturated paste in a soil sample taken from 10–20 cm depth.

Soil stratigraphy was described from soil plugs dug with a shovel to approximately 50 cm using standard methods (SSDS 1993). Where possible, a soil core or tile probe was used to extend the description and to determine the depth to underlying gravel, if present. Descriptions for each profile included the texture and color of each horizon, the depth of organic matter, the depth of thaw, the type and percentage of coarse fragments, and the presence and character of mottling. All profiles were photographed. To aid analyses, textural differences within a soil profile were grouped into a single simplified texture (i.e., rocky, sandy, loamy, clayey, or organic) for a site based on the dominant texture in the top 50 cm.

Vegetation structure and composition were assessed semi-quantitatively. Percentage cover of individual species in a vegetation type was estimated visually to the nearest 5% if over 10% and to the nearest 1% if below 10%. Dominant species were noted and a species list was assembled. Total cover of growth-form types (e.g., tall shrubs, low shrubs, graminoids, etc.) was evaluated independently of individual species and cross-checked for accuracy. All sites were photographed. Most species were identified in the field, and taxonomic nomenclature followed Viereck and Little (1972) for shrubs, Hultén (1968) for other vascular plants, and Vitt et al. (1988) for mosses and lichens. Unknown species

were collected for later identification. A more complete inventory was conducted concurrently by CRREL (Duffy 1999).

For the map verification sites, only vegetation structure and dominant plant species were listed. In addition, a preliminary ecotype and Alaska Vegetation Classification class was assigned in the field.

Classification

Ecosystem classification was approached at two levels. First, individual ecosystem components were classified and coded using standard classification systems developed for Alaska (Table 1). Second, these ecosystem components were integrated to classify ecosystems at three spatial scales using a variety of differentiating criteria (Table 2).

Ecosystem components

Vegetation types initially were classified to Level IV of the Alaska Vegetation Classification (Viereck et al. 1992), from data collected at sample sites, based on structural and floristic criteria. Geomorphic units were classified according to a system based on landform–soil characteristics for Alaska originally developed by Kreig and Reger (1982) and modified for this study. During classification of geomorphic units, we also relied on the geologic map of the Mt. Hayes Quadrangle (Péwé and Holmes 1964), the terrain unit maps in Kreig and Reger (1982), and the glacial maps and terrain descriptions in Péwé and Reger (1983). Organic units were those defined in the wetland classification for Canada (NWWG 1988). Surface-forms were classified according to the system developed by Washburn (1973) for periglacial microtopography. Soils were classified according to *Keys to Soil Taxonomy* (Soil Survey Staff 1998).

Ecosystems

Ecotypes (local ecosystems) descriptively integrate the climate, physiography, soil texture, soil moisture, and vegetation type of a discrete area. We classified ecotypes doing by the following:

- Simplying and aggregating detailed ground descriptions of ecological components.
- Identifying ecological relationships among terrain features by developing graphic profiles of ecosystem components along toposequences.
- Deriving a reduced set of ecotypes by identifying the most common relationships and central tendencies.

In developing the ecotype classes, we also tried to use ecological characteristics (primarily geomorphology and vegetation structure) that could be interpreted from aerial photographs. We also developed a nomenclature for ecotypes that explicitly relates ecological characteristics in a terminology that can be easily understood.

Because ecosystems are highly complex and variable, it was necessary to aggregate detailed characteristics described in the field (e.g., soil stratigraphy and vegetation composition). For each component, we used a hierarchical approach to aggregation (Fig. 4). For geomorphology, we hierarchically aggregated clasts, textures, layers, and lithofacies into geomorphic units (architectural elements) using the approaches of Miall (1985) and Brown (1997). Geomorphic units were assigned to physiographic settings based on their erosional or depositional processes (see Appendix A). Surface-forms were simplified into a reduced set of slope elements (i.e., crest, upper slope, lower slope, toe, flat). For vegetation, we used the structural levels of the Alaska Vegetation Classification (Viereck et al. 1992) because they are more readily identifiable on aerial photography than is floristic composition.

We identified common relationships among ecosystem components by looking at graphic profiles and using contingency tables. The contingency tables successively sorted plots by climate zone, physiography, texture, geomorphic unit, drainage, and vegetation type. From these tables, common associations were identified and unusual associations either were lumped with those with similar characteristics or excluded as unusual (outliers). Our philosophy was that it was better to identify strong relationships that could be used for prediction and mapping than to create additional rules and classes that only increase confusion and degrade accuracy.

Ecotype names were based on the simplified ecosystem components. For example, the full name for an ecotype for an individual plot would be Boreal Upland Rocky Moist Mixed Forest, based on climatic, physiographic, textural, hydrologic (moisture), and vegetative components, respectively. Because this generated a large number of specific ecotypes (113) from the 252 field plots, we aggregated many similar types into a reduced set of ecotypes (48). Some textural classes were grouped (e.g., rocky and loamy) because the vegetation classes were similar, or similar vegetation structures (e.g., open and closed black spruce) were grouped because species composition was similar. This grouping relied on identifying the most frequently occurring components. Overall, we tried to balance both the need to differentiate ecological characteristics and the need to minimize the number of classes for management purposes. This approach to classifying ecotypes provided a reduced set of broader groups, although the grouping can be done in any number of ways and other users may wish to group characteristics in different ways

Table 1. Coding system for the ecological land classification for Fort Greely.

Code	*Class*	*Code*	*Class*
	GEOMORPHIC UNITS (modified from Kreig and Reger 1982)	144	Closed Paper Birch Forest
011	Weathered Bedrock (Bxw)	145	Closed Quaking Aspen Forest
012	Residual Soil over Weathered Bedrock (Bxr)	147	Closed Quaking Aspen-Balsam Poplar Forest
015	Mountain Complex: Bxw + Bxr + Ct	151	Open Paper Birch Forest
016	Rugged Mountain Complex: Bxw + Ct	152	Open Quaking Aspen Forest
330	Solifluction Deposits *	153	Open Balsam Poplar Forest
335	Talus (Ct)	154	Open Paper Birch-Quaking Aspen Forest
371	Lowland Loess (Ell)	162	Balsam Poplar Woodland
372	Upland Loess (Elu)	165	Broadleaf-Shrub Woodland (post burn)
373	Frozen Upland Silt (Elx)	171	Closed Spruce-Paper Birch Forest
374	Loess, Undifferentiated/Old Moraine (El/Gmo)	173	Closed Spruce-Paper Birch-Quaking Aspen Forest
375	Lowland Loess/Old Moraine (Ell/Gmo)	174	Closed Quaking Aspen-Spruce Forest
376	Lowland Loess/Glaciofluvial, Undifferentiated (Ell/GF)	175	Closed Balsam Poplar-White Spruce Forest
377	Loess, Undifferentiated/Young Moraine (El/Gmy)	176	Closed Spruce–Quaking Aspen–Balsam Poplar Forest
441	Meander Floodplain Riverbed Deposit (Fmr)	181	Open Spruce-Paper Birch Forest
445	Meander Active-floodplain Cover Deposit (Fmca)	182	Open Quaking Aspen-Spruce Forest
447	Meander Inactive-floodplain Cover Deposit (Fmci)	184	Open Spruce-Balsam Poplar Forest
448	Meander Abandoned Floodplain	191	Spruce–Paper Birch Woodland
452	Abandoned-floodplain Cover Deposit (Fpac/ Fpr)	192	Spruce–Quaking Aspen Woodland
481	Headwater Stream, Riverbed Deposit (Fhr)*	211	Open Black Spruce Dwarf Tree Scrub
482	Headwater Stream, Active-floodplain Cover Deposit* (Fhca)	213	Open Quaking Aspen Dwarf Tree Scrub
		214	Open Balsam Poplar Dwarf Tree Scrub
483	Headwater Stream, Inactive-floodplain Cover Deposit*	216	Black Spruce Dwarf Tree Woodland
484	Headwater Stream, Abandoned Floodplain*	221	Closed Tall Willow Shrub
487	Headwater Floodplain-Steep, Undifferentiated	222	Closed Tall Alder Shrub
488	Headwater Floodplain-Lowland, Undifferentiated	224	Closed Tall Alder-Willow Shrub (riverine)
502	Alluvial Fan, Active Riverbed	231	Open Tall Willow Shrub (riverine)
503	Alluvial Fan, Inactive Riverbed	232	Open Tall Alder Shrub
504	Alluvial Fan, Abandoned Riverbed Deposit (Ffrb)	241	Closed Shrub Birch Shrub
506	Alluvial Fan, Active Cover Deposit*	242	Closed Low Willow Shrub
520	Retransported Deposits, Lowland (Fsl)	243	Closed Low Shrub Birch-Willow Shrub
521	Retransported Deposit, Hilly	245	Closed Low Alder–Willow Shrub
612	Ice-cored Moraine (Gmi)	246	Closed Low Shrub Birch-Ericaceous Shrub
621	Older Moraine (Gmo)	252	Open Low Mixed Shrub-Sedge Tussock Meadow
622	Younger Moraine (Gmy)	253	Open Low Mesic Shrub Birch-Ericaceous Shrub (alpine)
701	Glaciofluvial Deposit, Undifferentiated (GF)		
702	Glaciofluvial Outwash, Active Riverbed (Gfora)	255	Open Low Shrub Birch-Ericaceous Shrub Bog
703	Glaciofluvial Outwash, Inactive Riverbed (Gfori)	256	Open Low Ericaceous Shrub Bog
705	Glaciofluvial Outwash, Abandoned Riverbed (Gforb)	257	Open Low Shrub Birch–Willow Shrub
712	Glaciofluvial Outwash, Inactive Cover (Gfoci)	259	Open Low Shrub (post burn, uplands)
715	Glaciofluvial Outwash, Abandoned Cover (GFocb)	260	Open Low Willow Shrub
718	Glaciofluvial Outwash, Terrace	262	Open Low Willow-Graminoid Shrub Bog (fen)
750	Lacustrine (L)	265	Open Low Alder Shrub
780	Human-made Deposits (H)	266	Open Low Silverberry Shrub
843	Drainage Fen (Ofd)*	268	Sagebrush–Grass
854	Shore Fen (Ofsh)*	271	Dryas Dwarf Shrub Tundra
872	Basin Bog (Obb)*	272	Dryas–Sedge Dwarf Shrub Tundra
874	Collapse-scar bog (Obc)*	273	Dryas-Lichen Dwarf Shrub Tundra
885	Shore Bog (Obsh)*	280	Ericaceous Dwarf Scrub
888	Veneer Bog (Obv)*	281	Bearberry Dwarf Shrub Tundra
911	Upper Perennial River, Non-glacial (Wrun)	285	Cassiope Dwarf Shrub Tundra
912	Upper Perennial River, Glacial (Wrug)	303	Dry Fescue
928	Deep Isolated Lake, Morainal	304	Midgrass-Shrub (S-facing bluff)
936	Deep Isolated Ponds, Thaw	305	Midgrass–Herb
927	Deep Isolated Lake, Bedrock	306	Hair-grass
943	Shallow Isolated Ponds, Riverine	311	Bluejoint Meadow
		312	Bluejoint–Herb
	VEGETATION (after Viereck et al. 1992)	313	Bluejoint–Shrub
0	Barren	314	Tussock Tundra
1	Water (<5% vegetated)	318	Subarctic Lowland Sedge Moist Meadow
10	Partially Vegetated	322	Sedge–Birch Tundra
112	Closed White Spruce Forest	331	Wet Sedge Meadow Tundra
113	Closed Black Spruce Forest	340	Lowland Sedge Wet Meadow (riverine)
124	Open White Spruce Forest	341	Subarctic Lowland Sedge–Shrub Wet Meadow
125	Open Black Spruce Forest (w/ ericaceous shrub, flat, N-facing)	341	Subarctic Lowland Sedge–Shrub Wet Meadow
		351	Dry Seral Herbs
128	Open Black Spruce-White Spr. Forest (S-facing, ridges)	361	Mesic Mixed Herbs
		362	Fireweed
133	White Spruce Woodland	381	Pondlily
134	Black Spruce Woodland	362	Fireweed
135	Black Spruce–White Spruce Woodland		

*Present, but too small or indistinct to map

Table 2. Comparison of systems for differentiating ecosystems at various scales.

Ecological units					*Scale*		
Bailey (1996), Forman (1995)	*Delcourt and Delcourt (1988)*	*ECOMAP (1993)*	*Canadian (Wiken 1981)*	*Klijn and Udo de Haes (1994)*	*Typical map scale*	*Typical areal extent*	*Differentiating characteristics used in this study*
Region (Forman)	Continent	Domain		Ecozone	1:20,000,000	10^{12} m^2 1,000,000 km^2	Continents with related climate.
Or Ecoregion		Division		Eco-province	1:10,000,000	10^{11} m^2 100,000 km^2	Climatic subzones with broad vegetation regions.
(Bailey) (macro-scale)	Macroregion	Province	Ecoregion	Ecoregion	1:5,000,000	10^{10} m^2 10,000 km^2	Climate, a geographic group of landscape mosaics (e.g., Interior Highlands).
Land-scape (Forman) or Land-scape	Mesoregion	Section	Ecodistrict	Ecodistrict	1:1,000,000	10^9 m^2 1,000 km^2 100,000 ha	Major landforms or Physiographic units within a climatic region (e.g. Delta Highlands).
Mosaic (Bailey) (meso-scale	Microregion	Sub-section		(Eco-subdistricts by ABR)	1:250,000	10^8 m^2 100 km^2 10,000 ha	Physiographic units at larger scale based on associations of geomorphic units (e.g., grouping of weathered bedrock on crests, residual soil on upper slopes, retransported lowland deposits at toe of slopes, and headwater streams in drainages).
		Landtype Assoc-iation	Ecosection	Ecosection	1:100,000	10^7 m^2 10 km^2 100 ha	Geomorphic units with homogeneous lithology, mode of deposition, depth, texture, and water properties. Similar concepts include soil catena, toposequence, and soil association. (e.g., bedrock or floodplain cover deposit).
Local eco-system (Forman) or site (Bailey) (micro-scale)	Macrosite	Landtype	Ecosite	Ecoseries	1:25,000–50,000	10^4–10^6 1 km^2 10–100 ha	A subdivision of a geomorphic unit that has a uniform topoclimate based on elevation, aspect, slope position, and soil drainage. Similar concepts include soil series, homogeneous abiotic site conditions, climax vegetation, assemblages of vegetation types on soil series (e.g., ester soil series on north slopes of bedrock soils).
	Mesosite	Landtype Phase	Ecoelement	Ecotype (Ecotope)	1:5,000 –25,000	10^2–10^4 0.1–10 ha	Vegetation type or successional stage (e.g., Balsam poplar on floodplain cover deposit).
	Microsite	Site		Ecoelement	1:1000 –5,000	10^{-2}–10^2 <0.1 ha	Uniform microsites within stand (e.g., polygon rim vs. center).

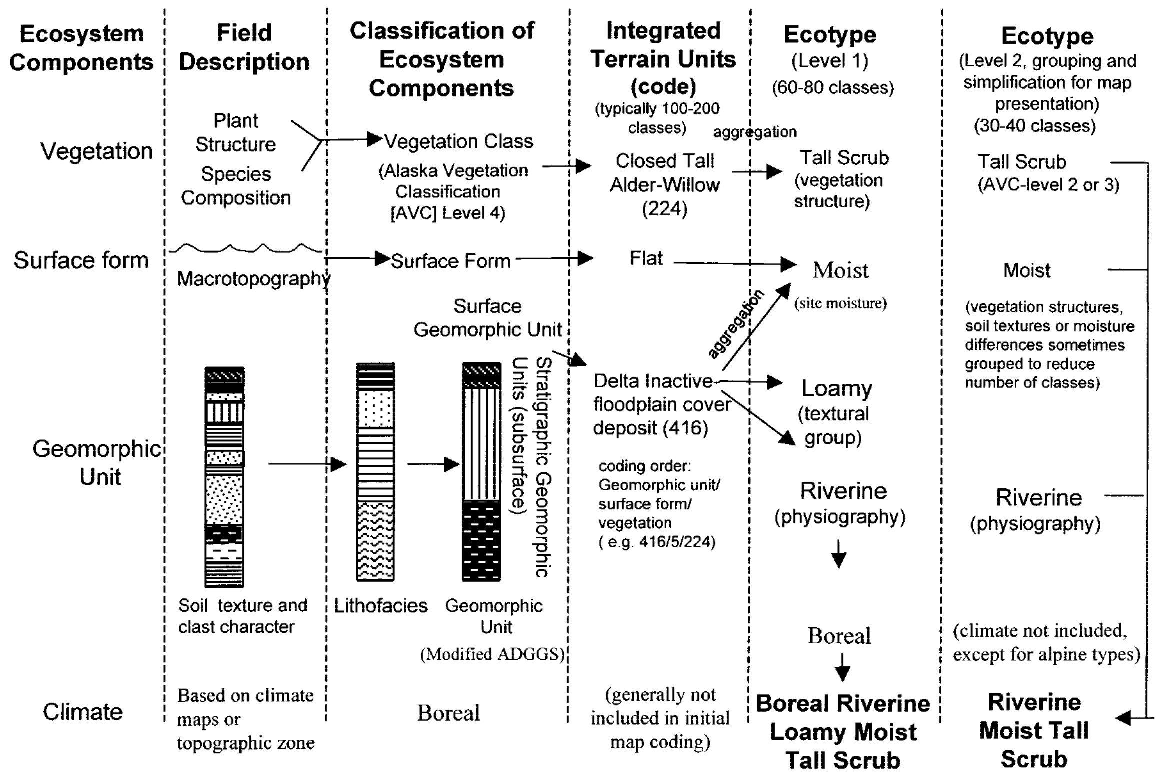


Figure 4. System of hierarchically classifying ecosystem components into integrated terrain units (ITU) and further aggregating and simplifying ITUs into ecotypes.

for their own individual purposes. Ground data can be reclassified and analyzed by regrouping characteristics in Appendix A and applying the new organization to the plot database (Appendix B).

To classify ecosystems at smaller spatial scales, we used geomorphic and physiographic criteria (Table 2). Ecosections were differentiated on the basis of their geomorphic patterns and processes, and we named them after geomorphic units. We classified ecodistricts and ecosubdistricts on the basis of general physiographic characteristics that were related to associations of geomorphic units. Because each ecodistrict is unique, we named the areas on the basis of a general physiographic descriptor (e.g., lowland or highland) and a prominent geographic feature (e.g., nearby creek or mountain).

Mapping

We mapped the ecosystems at three scales: ecotype (1:50,000), ecosection (1:100,000), and ecodistrict and ecosubdistrict (1:250,000). The ecotype map was based on the unsupervised classification of the spectral characteristics of the Landsat Thematic Mapper (TM) imagery and the ruled-based classification of spectral clusters using ancillary data. The ecosection and ecodistrict maps were based on photo-interpretation. By incorporating vegetation structure from the spectral classification of Landsat Imagery, geomorphology derived from the ecosections map, and physiography from the digital elevation model and ecodistricts map, we could integrate several landscape components in a way that was similar to the integrated-terrain-unit (ITU) method used for mapping Fort Wainwright (Jorgenson et al. 1999).

Ecotypes

Ecotypes were mapped by computer processing of Landsat TM imagery. The processing followed a series of sequential and iterative steps: acquiring data, correcting and classifying the image, using photo interpretation techniques on it, developing conceptual models of ecological relationships, and developing a final classification using a rule-based system that incorporated ancillary data (Fig. 5).

Data acquisition included compiling satellite imagery, aerial photography, and other ancillary information. The Landsat TM satellite image (Path 68, Row 15), obtained on 10 August 1994, has a spatial resolution (pixel size) of 28.5 m. Aerial photography included complete coverage of 1979 and 1980 in color-infrared (1:63,000 scale) and 1996 in true color (1:24,000), and partial coverage of 1996 in true color (approximately 1:1000). The color-infrared photography was used for mapping ecosections. We referred to the medium-scale

1996 photography during spectral classification. We obtained the large-scale true color photos using a 35-mm camera and a small fixed-winged aircraft that was flown along widely spaced transects across the base. These photos were also used for reference during spectral classification. Digital elevation and digital line graph data for 1:63,000 scale quadrangles were obtained from the USGS.

The Landsat TM image was georectified to UTM 6, NAD 27 using 66 control points, which we obtained from prominent features on 1:63,000 USGS quadrangles using ERMapper software; RMS error was 1.0 pixels (28.5 m). For radiometric correction, the image was destriped using a principal components analysis (PCA) routine from IDRISI software.

In spring 1998, initial image classification was done using a cluster analysis algorithm (ISOCLASS) in ERMapper to generate 81 spectral classes. The processing incorporated bands 5 and 7 and two new bands derived from these bands. A "vegetation index" was created using the ratio of bands 4/3. The second band was based on the PCA of bands 1, 2, and 3 because these

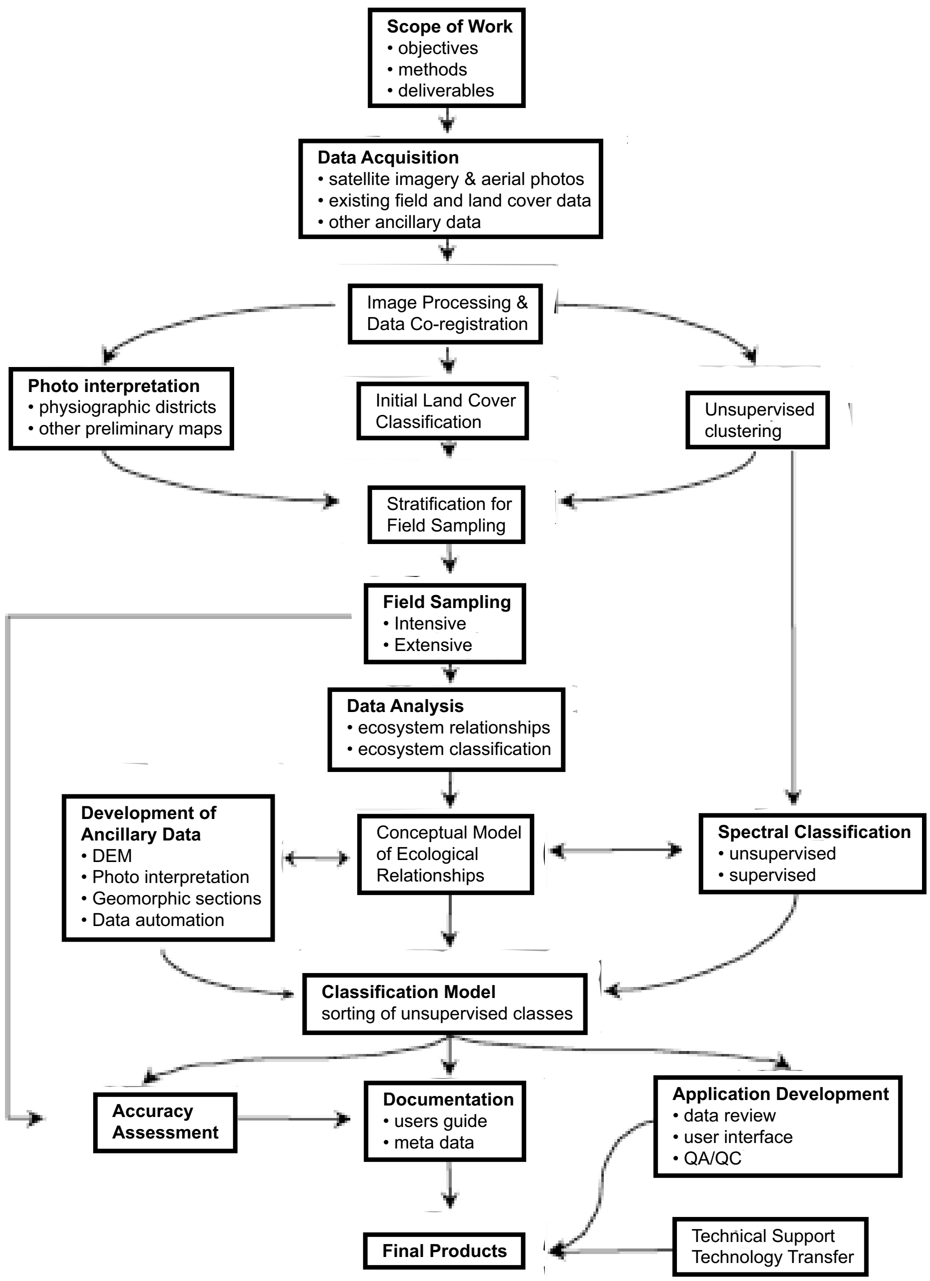


Figure 5. Flow diagram of steps used in image processing and classification for creation of the ecotype map for Fort Greely.

bands were highly correlated. The unsupervised classification was stratified by ecodistrict to maximize separation of spectral signatures within areas of similar physiography and ecological characteristics. A total of 18 alpine, 29 highland, 28 lowland, and 11 riverine spectral classes was generated.

For field verification of spectral classes, we checked ground truth in 17 areas distributed within the various ecodistricts. In each area, 10–20 points were sampled along a meandering route (3–5 km long) designed to sample all the spectral classes in the area. Points initially were selected from the classified image in the office and were chosen to fall within patches that had at least 3 × 3 cells of the same class. GPS points were generated for the centers of these patches. In addition, the classified image was copied onto an acetate overlay for the aerial photo for each area. The GPS coordinates, aerial photographs, and acetate overlays were used to find the selected points in the field.

We initially classified the spectral signatures by correlating spectral classes with field-determined ecotypes. For classes that did not have sufficient field data, we used the large- and intermediate-scale color photography to interpret the ecotype represented by each spectral class. The large-scale photography, obtained when vegetation was in fall color, was particularly useful in determining vegetation structure, and the dominant plant species usually could be identified by their unique fall colors.

To improve the classification of spectral classes, we used a rule-based approach that incorporated ancillary data and conceptual models of ecological relationships to separate classes that had similar spectral signatures (Hutchinson 1982, Satterwhite et al. 1984, Joria and Jorgenson 1996). The conceptual model was based on an ecological relationships matrix that identified associations among climatic zones, elevation, physiographic districts, geomorphic units, slope, moisture, vegetation structure, and vegetation composition. For the most part, the ecotypes were mapped by associating physiographic and geomorphic characteristics obtained from the ecodistrict and ecosection maps with the vegetation structure obtained from the classified Landsat image. For example, dwarf scrub types in alpine areas and floodplains were differentiated using the physiographic map to create Alpine Rocky Dry Dwarf Scrub and Riverine Gravelly Dry Dwarf Scrub. Confusion between dark waterbodies, closed spruce forests, and steep, north-facing slopes was eliminated by buffering around lakes and ponds in the USGS DLG layer, and classifying only those pixels that occurred within the buffers as lakes and ponds. Areas with clouds and shadows were reclassified on the basis of elevation relationships and what ecotypes were most abundant in the affected areas. While reclassifying clouds and shadows did create some error, we did this to provide complete coverage of ecotypes. Areas occluded by smoke were reclassified on the basis of relationships particular to the physiographic district where the smoke occurred. Differences in gravelly and loamy ecotypes were differentiated using the geomorphic units. Overall, dozens of rules were created using input from the spectral classes, DEM, DLG, ecosection (geomorphic units), and ecodistrict (physiography) layers. After we initially developed the decision rules, we visually evaluated the resulting map to determine whether the rules were suitable for the scene as a whole. We then changed the rules as necessary through several iterations before the modeled map was made final.

Eleven ecotypes (i.e., Lowland Dwarf Scrub Bog, Riverine Wet Meadow) could not be mapped because they were relatively rare, occurred in small patches, or their spectral signatures were not sufficiently distinct. Classes that could not be distinguished with the satellite imagery were included as errors within the other classes. Inherent to this approach is that the classification was driven by the ground data and what could be distinguished on the ground, not by what could be distinguished on the imagery. To facilitate use of the map for management, the classified image was filtered to eliminate most small patches (1–3 cells).

We assessed the accuracy of the final ecotype map by comparing the ecotypes of original ground-reference sites with their final map classes, because funding constraints did not allow the additional fieldwork that would have been required to collect independent data. While this is not a truly valid assessment of the accuracy because the data were not independent of those used to create the map, it does provide an indication of map accuracy. Plots for which the ground-determination was not a mapped class were excluded, leaving 332 plots for the analysis. Omission and commission errors were summarized by ecotype.

Ecosections and ecodistricts

Ecosection maps were based on photo-interpretation of landform characteristics on 1:63,000-scale color-infrared photography taken in 1979 and 1980. Boundaries were delineated on 1:100,000-scale prints of a false-color composite of the georeferenced Landsat image. The boundaries were digitized and codes entered for each polygon.

Ecodistricts were delineated on a 1:300,000-scale print of the Landsat image. During this process, we referred to the map of land resource areas used in the exploratory soil survey of Alaska (Rieger et al. 1979) and the map of ecoregions of Alaska (Gallant et al. 1995) to try to provide consistency in boundaries.

RESULTS AND DISCUSSION

Hierarchical organization of ecosystem components

Toposequences

The principal foundation for ecosystem classification was the survey of ecosystem components (e.g., topography, geomorphology, soil, hydrology, permafrost, and vegetation) along seven toposequences. Cross-sectional profiles were constructed to illustrate relationships among ecosystem components of the seven toposequences (Fig. 6 and 7). The toposequences are two-dimensional views of the structure of the lithofacies that we used as the basis for classifying and mapping geomorphic units. Examples from various ecosubdistricts within the four ecodistricts (Hayes Mountains, Delta Highlands, Delta Lowlands, and Middle Tanana Floodplain, see section on *Ecodistricts*) are described below to illustrate some of the main ecological relationships within Fort Greely.

Within the Molybdenum Ridge Mountains (Transect 5), geomorphology is dominated by weathered bedrock and talus on steep slopes, and colluvium and retransported deposits on toe slopes (Fig. 7a). We assumed that permafrost generally was present, although rocky soils prevented positive determination. The soils on upper slopes were rocky, excessively drained, and lacked organic matter accumulations, whereas the soils on toe slopes were fine-grained with abundant rocks, poorly drained, and had thick organic matter accumulations. Vegetation (Alaska Vegetation Classification) ranged from partially vegetated on steep, exposed ridges to open low shrub birch–willow scrub on moist upper slopes to open black spruce dwarf tree scrub on lower slopes. Headwater floodplains supported open and closed tall alder scrub.

Within the Hayes Highland Plateau (Transect 3), the geomorphology was dominated by old glacial moraines, with minor amounts of headwater floodplain and organic deposits (Fig. 7b). Permafrost usually was present. The steeper, exposed slopes had well-drained, gravelly soils that supported open tall alder and open low shrub birch–ericaceous scrub. Gentle upper and lower slopes had saturated soils with thick organic matter accumulations and supported tussock tundra and open low shrub birch–ericaceous scrub. Small headwater streams had fluvial deposits with interbedded silts, sands, and organics and the saturated soils supported closed shrub birch scrub and wet sedge tundra.

Within the Little Delta River Glaciated Highlands (Transect 2), the geomorphology was dominated by glacial moraines, with glaciofluvial deposits near the moraine terminus (Fig. 7c). The soils on the moraines were highly variable, ranging from massive gravel on ridges to fines with trace gravel where eolian silt has accumulated, to stratified silt and sandy material in

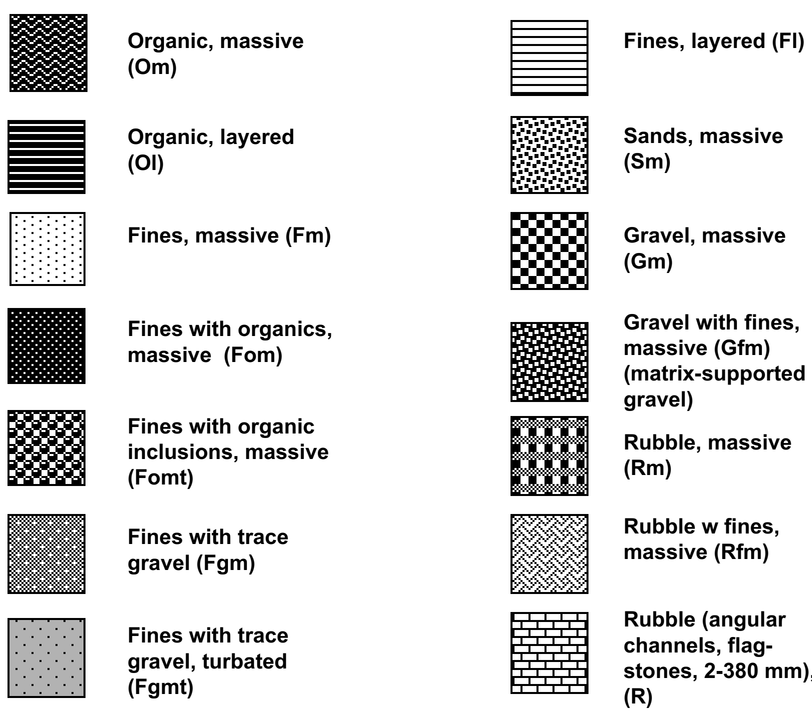
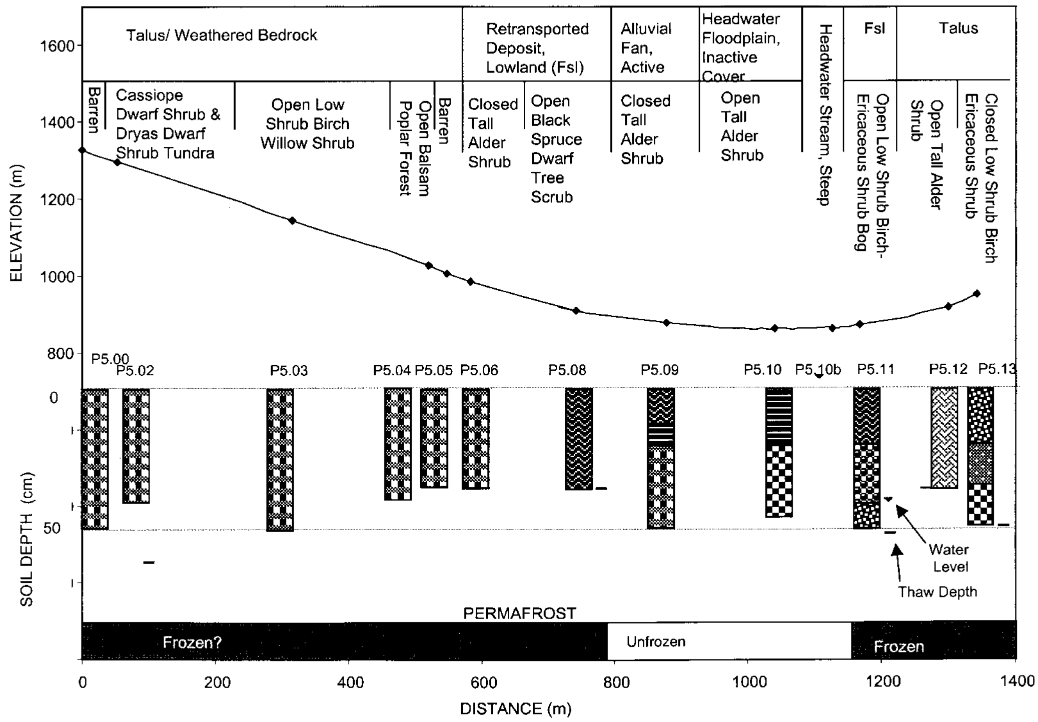
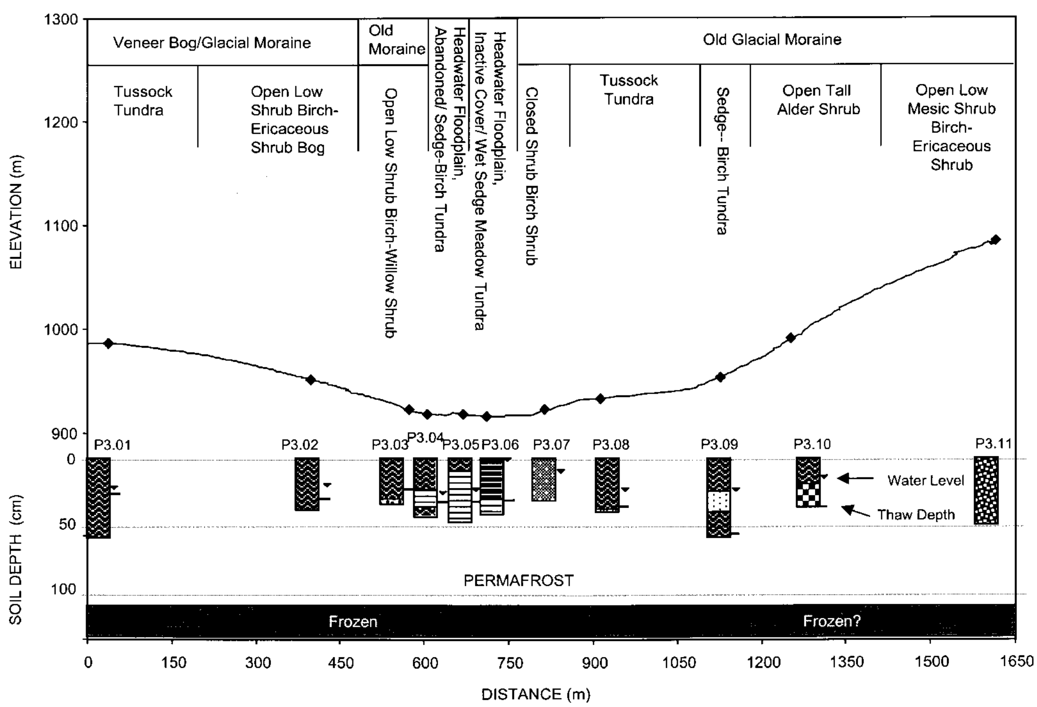


Figure 6. Soil patterns used for lithofacies encountered along toposequences on Fort Greely.

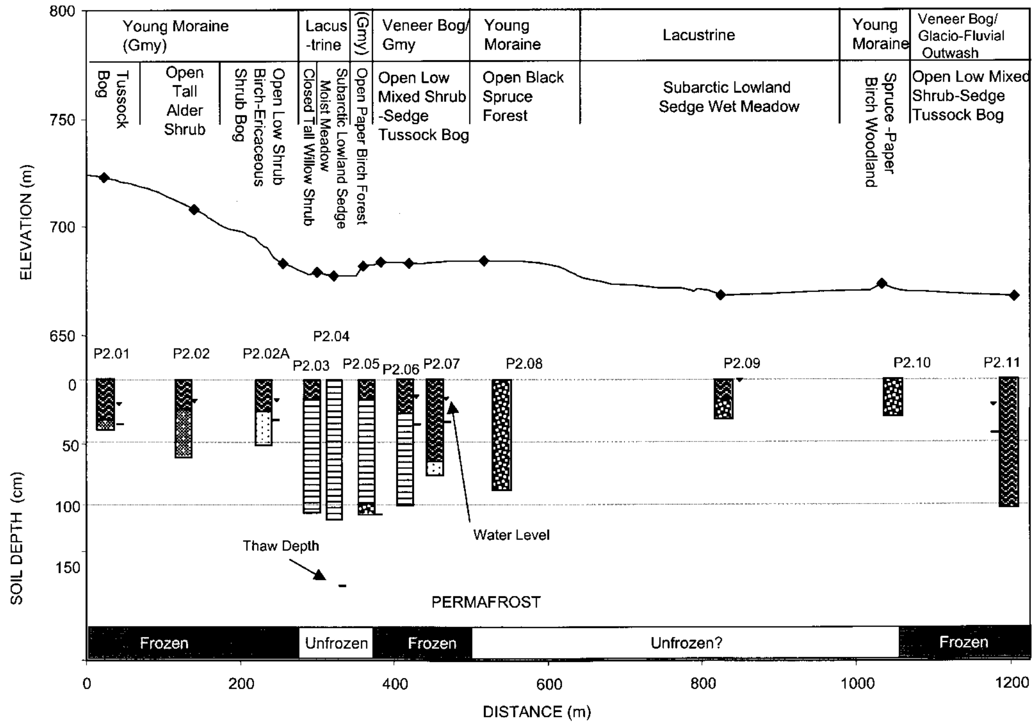


a. Transect 5 in the Molybdenum Ridge Mountains.

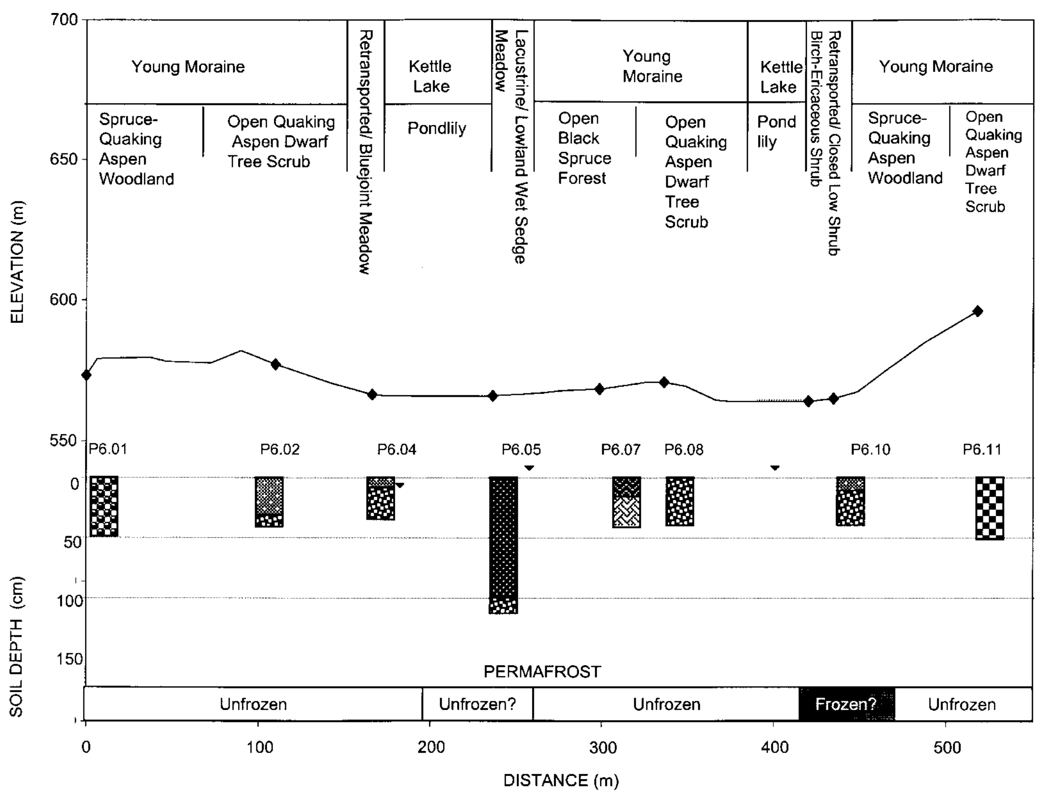


b. Transect 3 in the Hayes Highland Plateau.

Figure 7. Toposequences illustrating geomorphology, vegetation, elevations, soil stratigraphy, and permafrost occurrence. (See Figure 6 for key to lithofacies.)

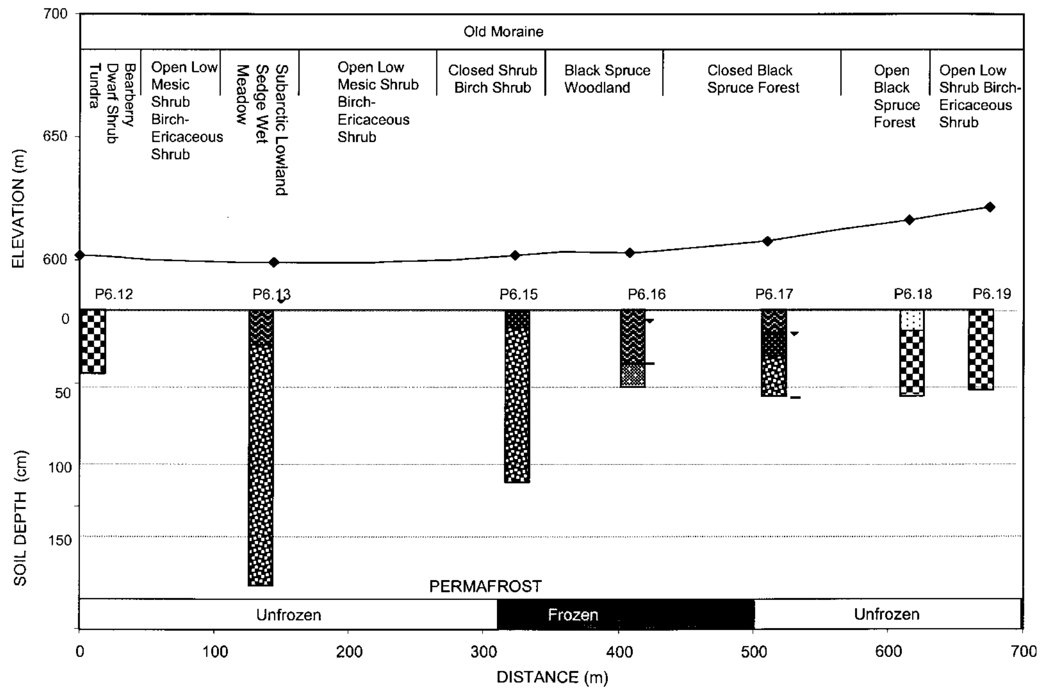


c. Transect 2 in the Little Delta River Glaciated Highlands.

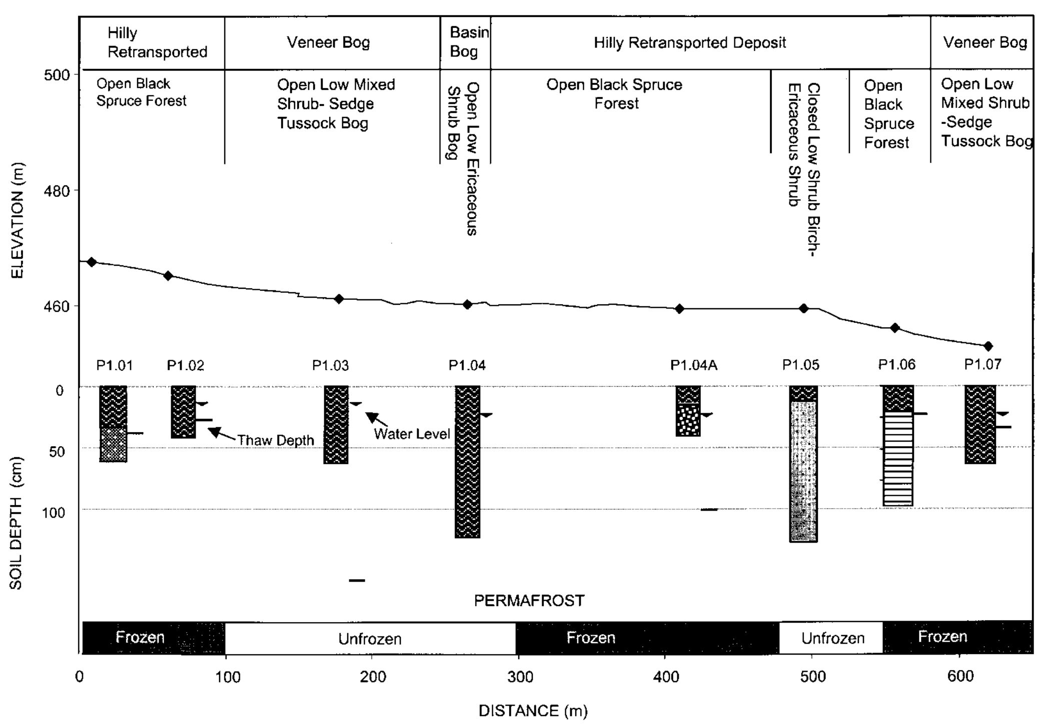


d. Transect 6a in the Jarvis Creek Glaciated Lowlands–Donnelly Moraine.

Figure 7 *(Cont'd).*

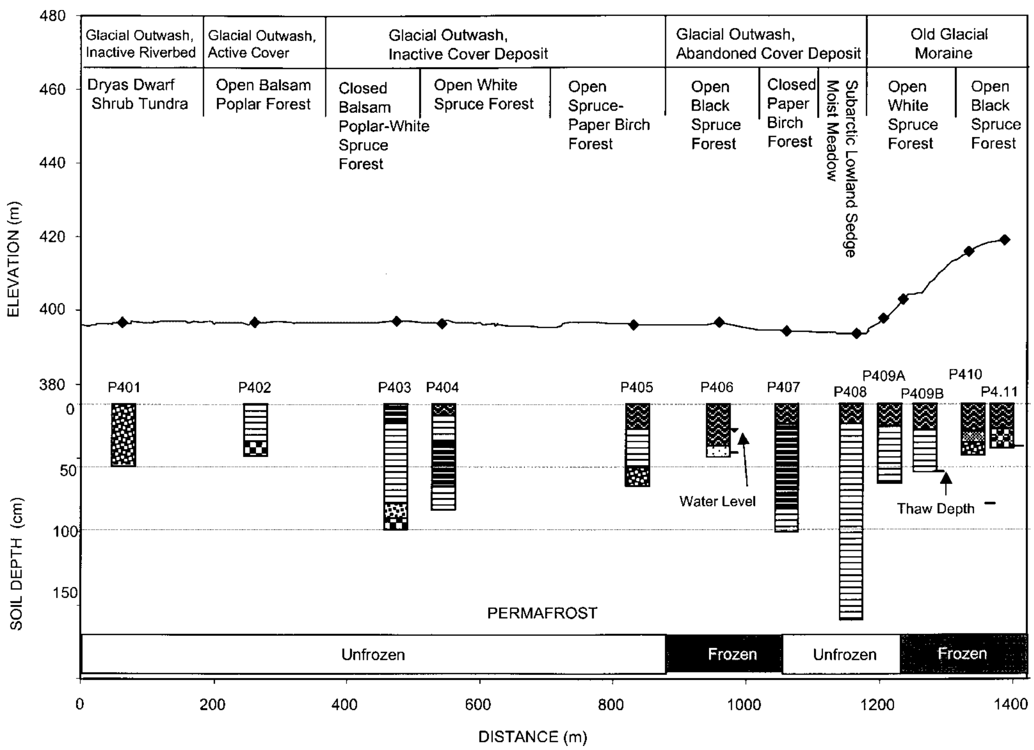


e. Transect 6b in the Jarvis Creek Glaciated Lowlands–Delta Moraine.



f. Transect 1 in the Lower Delta Creek Lowlands.

Figure 7 ***(Cont'd)*****. Toposequences illustrating geomorphology, vegetation, elevations, soil stratigraphy, and permafrost occurrence. (See Figure 6 for key to lithofacies.)**



g. Transect 4 in the Delta Creek Floodplain.

Figure 7 *(Cont'd).*

kettle depressions. Organic matter accumulation also was highly variable. Well-drained upland sites without permafrost had open paper birch forest and closed tall willow scrub. Poorly drained sites with permafrost had open low mixed shrub–sedge tussock bogs and open black spruce. Subarctic lowland sedge moist meadows, an uncommon vegetation type, occurred in somewhat well-drained, fine-grained lacustrine material in drained kettle basins.

Within the Jarvis Creek Glaciated Lowlands (Transect 6), the geomorphology was dominated by young moraines associated with the Donnelly glaciation and old moraines associated with the Delta glaciation. On the young moraine (Transect 6a), soils also were highly variable as described above, although organic accumulation was small (Fig. 7d). Vegetation on steep, gravelly, south-facing slopes had a unique vegetation type of open quaking aspen dwarf tree scrub, presumable because of the severe wind exposure. Lower, wetter slopes supported closed shrub birch–ericaceous scrub and open black spruce forest. Ponds and pond margins supported pondlily and subarctic lowland sedge wet meadow, respectively. On old moraines (Transect 6b), the topography was much more subdued, but gravelly soils were still common (Fig. 7c). More exposed ridges supported bearberry dwarf scrub tundra and open low mesic shrub birch–ericaceous scrub, both of which had abundant lichens. Poorly drained soils on slopes had permafrost and supported black spruce forests. Basins had thick organic matter accumulations and supported subarctic lowland sedge wet meadows.

Within the Lower Delta Creek Lowlands (Transect 1), the geomorphology was dominated by hilly retransported deposits associated with eroding Tertiary Nenana Gravel deposits and by organic deposits (Fig. 7f). Well-drained soils on crests supported closed shrub birch–ericaceous scrub, while poorly drained soils on gentle slopes supported black spruce forests, closed shrub birch–ericaceous scrub, and open low mixed shrub–sedge tussock bog. Basin bogs with thick organic accumulations in swales support an unusual type of open low ericaceous scrub bog.

Within the Delta Creek Floodplain (Transect 4), the geomorphology was dominated by glaciofluvial outwash riverbed deposits, inactive cover deposits, and abandoned floodplain deposits (Fig.7g). The transect extended onto an old moraine. The excessively drained, gravelly soils of the active riverbed were barren to partially vegetated with *Dryas* dwarf scrub tundra. The well-drained loamy soils with interbedded silts, sands,

and organics supported closed balsam poplar–white spruce forests, open white spruce forests, and open spruce–paper birch forests. The poorly drained soils on the abandoned floodplain had thick organic accumulations and supported open black spruce forests and closed paper birch forests.

Ecosystem components

We developed hierarchical relationships among ecosystem components by successively grouping data from survey plots by climate, physiography, soil texture, geomorphology, slope position, drainage, permafrost, vegetation structure, and vegetation composition (Table 3). Frequently, geomorphic units with similar texture or genesis were grouped (e.g., loamy and organic were grouped for some lowlands) to reduce the number of classes. Ecotypes then were derived from these tabular associations to differentiate ecotypes that have different sets of associated characteristics (see the *Ecotype* section for more detailed descriptions and analysis).

This hierarchical grouping revealed that there were close associations among soil texture, geomorphology, slope position, drainage, and soils, and that often there were several vegetation types that occurred on a geomorphic unit or soil type. These vegetation types generally are associated because they occur along a successional sequence. For example, herb–moss, tall scrub, broadleaf forest, mixed forest, and needleleaf forest is the typical successional sequence of vegetation development after fire (Foote 1983, Viereck et al. 1983).

The successive grouping of ecosystem components helps differentiate many forest types. For example, aspen generally was associated with upland areas and gravelly lowlands, while balsam poplar generally was restricted to riverine areas. Birch, white spruce, and black spruce, however, were found over a wide range of conditions. For more detailed presentation of floristic differences among ecotypes, see the discussion of vegetation composition under the *Ecotype* section.

A large question is how well these general relationships conform to the data set and whether they can be used reliably to extrapolate trends across the landscape. During development of the relationships, 25% (63/252) of the field observations were excluded from the table because of inconsistencies among physiography, texture, geomorphology, moisture, and vegetation. Some of the main inconsistencies, or departure from the central concepts, included frequent grouping of rocky sites with moist loamy ecotypes because of cutpoint problems associated with the 50-cm criteria used to define texture, occasional occurrence of moist sites in wet lowland ecotypes, occasional absence of permafrost in wet lowland ecotypes, and occasional presence of permafrost in moist upland ecotypes.

The percentage of inconsistent plots (25%) was relatively high compared with the consistency of associations (17%) obtained for Fort Wainwright (Jorgenson et al. 1999). We attribute this to the following:

- The complexity of loess distribution and the glaciated terrain, which made soil properties extremely patchy.
- The higher elevations, which had broader transition zones from closed canopy forests to woodland forests to alpine shrublands.
- The abundance of burned areas in various successional stages.

During the development of generalized trends, our perspective was that it was better to preserve distinct, general trends, rather than include all the exceptions that violate the trends, and thereby increase confusion among classes. We believe that there is a limit to how well patterns on the landscape can be described, and that some proportion (in this case 25%) of sites cannot readily be explained because they are transitional (ecotones) or have historical factors (e.g., change in water levels, disturbances) that may cause the ecosystem (particularly soils) to vary unpredictably with current environmental conditions. The occurrence of these inconsistencies provides a theoretical upper limit for the accuracy of mapping of about 75%, because a certain portion of the landscape will not fit readily into any of the classes.

The advantage of this hierarchical approach is that, by combining physiography and vegetation structure, the resulting classes are relatively good at differentiating soil characteristics and vegetation composition. This approach is particularly useful for mapping, where the interpreter can easily distinguish physiography (e.g., flat lowlands versus hilly uplands) and vegetation structure (e.g., needleleaf trees, broadleaf trees, shrubs, and graminoids), whereas distinguishing tree species (e.g., birch versus poplar) or shrub species (e.g., dwarf birch versus willow) is difficult. Another advantage is that it links vegetation with soil characteristics. This linkage is particularly important for differentiating ecotypes that may have different sensitivities to disturbance. For example, lowland wet broadleaf forest (dominated by paper birch) was almost always associated with ice-rich permafrost and, therefore, is susceptible to thermokarst that can lead to irreversible development of entirely different ecosystems after disturbance. In contrast, upland moist broadleaf forest (also dominated by birch) almost always was associated with well-drained, thaw-stable soils and generally can recover to similar ecological conditions a few decades after disturbance.

Table 3. Hierarchical associations among ecosystem components for ecotypes found within Fort Greely.

Climate	*Physiography*	*Soil Texture*	*Geomorphic Unit*	*Slope Position*	*Drainage*	*Permafrost*	*Vegetation: Structure**	*Vegetation: Indicator Species†*	*Ecosystem Class*
Alpine	Upland and Glaciated	Rocky	Weathered Bedrock, Talus, Ice-cored Moraine	Crest, Upper	Excessive	Present	Barrens	Barren	Alpine Rocky Dry Barrens
							Dwarf Scrub	*Dryas*–Lichen	Alpine Rocky Dry Dwarf Scrub
					Well	Present	Low Scrub	*Betula nana–Salix pulchra,* *Salix pulchra–Calamagrostis canadensis*	Alpine Moist Low Scrub
							Tall Scrub	*Alnus crispa–Calamagrostis canadensis,* *Alnus crispa–Empetrum nigrum*	
	Lowlands	Loamy and Organic	Solifluction Deposits, Retransported Deposits, Organic Deposits	All	Poor	Present	Low Scrub	*Betula nana–Vaccinium uliginosum,* *Carex bigelowii–Salix pulchra*	Alpine Wet Low Scrub
							Moist Graminoid	*Eriophorum vaginatum–Carex bigelowii*	Alpine Wet Tussock Meadow
	Floodplain	Loamy	Headwater Floodplain , Alluvial Fans	Flat	Poor	Present	Wet Gramin. Low Scrub	*Eriophorum angustifolium–Carex aquatilis* *Betula nana–Salix pulchra*	Alpine Wet Meadow Alpine Wet Low Scrub
Boreal	Upland and glaciated	Rocky	Residual Soil, Talus, Old Moraine, Young Moraine	Crest, Upper	Excessive	Absent	Dry Graminoid	*Artemisia frigida – Juniperus communis*	Upland Rocky Dry Meadow
							Low Scrub	*Betula nana–Stereocaulon* sp.	Upland Rocky Dry Low Scrub
							Deciduous Forest	*Populus tremuloides–Arctostaphylos uva-ursi* *Populus tremuloides (dwarf)–Stereocaulon sp.*	Upland Rocky Dry Broadleaf Forest
					Well, Poor	Present, Absent	Needleleaf Forest	*P. mariana–Ledum groenlandicum*	Upland Wet Needleleaf Forest
		Loamy	Upland Loess	Crest, Upper	Well	Absent	Needleleaf Forest	*Picea glauca-Alnus crispa* *Picea mariana–P. glauca–Hylocomium splendens*	Upland Moist Needleleaf
							Mixed Forest	*Betula papyrifera–Picea mariana–Betula nana* *Betula papyrifera–Picea glauca-Hylocomium splendens*	Upland Moist Mixed Forest
							Deciduous Forest	*Betula papyrifera–Calamagrostis canadensis*	Upland Moist Broadleaf Forest
							Tall Scrub	*Alnus crispa–Calamagrostis canadensis*	Upland Moist Low and Tall Scrub
								Populus tremuloides-Epilobium angustifolium	Upland Moist Low and Tall Scrub-disturbed
							Low Scrub	*Betula nana–Vaccinium uliginosum* *Betula nana–Salix pulchra* *Vaccinium uliginosum-Epilobium angustifolium*	Upland Moist Low and Tall Scrub Upland Moist Low and Tall Scrub-disturbed
							Moist Graminoid	*Calamagrostis canadensis*	Upland Moist Meadow (post-fire)
			Upland Frozen Loess	Upper	Poor	Present	Needleleaf Forest	*P. mariana–Ledum groenlandicum*	Upland Wet Needleleaf Forest

Table 3 *(cont'd)*. Hierarchical associations among ecosystem components for ecotypes found within Fort Greely.

Climate	*Physiography*	*Soil Texture*	*Geomorphic Unit*	*Slope Position*	*Drainage*	*Permafrost*	*Vegetation: Structure**	*Vegetation: Indicator Species†*	*Ecosystem Class*
Boreal (cont'd)	Glaciated	Loamy	Old Moraine, Young Moraine	Upper	Poor	Unknown	Tall Scrub	*Alnus crispa–Empetrum nigrum*	Lowland Moist Tall Scrub
				Basin	Well	Absent	Tall Scrub	*Salix pulchra–Calamagrostis canadensis*	Lowland Moist Tall Scrub
							Moist Graminoid	*Carex saxatilis Deschampsia caespitosa*	Lowland Moist Meadow
					Poor	Absent	Wet Graminoid	*Eriophorum angustifolium–Carex aquatilis*	Lowland Wet Meadow
	Lowland	Rocky	Glaciofluvial Outwash Deposit	Flat	Excessive and Well	Absent	Needleleaf Forest	*Picea glauca–P. mariana–Stereocaulon spp.*	Lowland Gravelly Needleleaf Forest
							Mixed Forest	*Picea glauca–Populus tremuloides–Sheperdia canadensis*	Lowland Gravelly Dry Mixed Forest
							Deciduous Forest	*Populus tremuloides-Arctostaphylos uva-ursi*	Lowland Gravelly Dry Broadleaf Forest
							Low Scrub	*Betula nana–Stereocaulon sp.*	Lowland Moist Gravelly Low Scrub
		Loamy	Lowland Retransported Deposit Glaciofluvial Outwash Abandoned Floodplain	Lower, Toe, Flat	Well	Absent	Tall Scrub	*Alnus crispa –Salix pulchra*	Lowland Moist Tall Scrub
							Moist Graminoid	*Carex saxatilis–Calamagrostis canadensis*	Lowland Moist Meadow
			Deposit		Poor	Present	Needleleaf Forest	*Picea mariana–Ledum groenlandicum*	Lowland Wet Needleleaf Forest
							Mixed Forest	*Betula papyrifera–Picea mariana-Equisetum sylvaticum*	Lowland Wet Mixed Forest
							Deciduous Forest	*Betula papyrifera–Equisetum sylvaticum*	Lowland Wet Broadleaf Forest
							Low Scrub	*Betula nana–Salix pulchra Betula nana–Picea mariana*	Lowland Wet Low Scrub
							Low Scrub-Tussock	*Eriophorum vaginatum–Picea mariana*	Lowland Tussock Scrub Bog
		Organic	Drainage Fen	Flat or Lower	Poor	Absent	Wet Graminoid	*Eriophorum angustifolium–Salix spp.*	Lowland Fen Meadow
			Veneer Bog	Lower, Flat, Basin	Poor	Present	Woodland Needleleaf Forest	*Picea mariana–Ledum groenlandicum*	Lowland Wet Needleleaf Forest
							Dwarf Scrub	*Sphagnum spp. –Rubus chamaemorus*	Lowland Dwarf Scrub Bog
							Low Scrub-Tussock	*Eriophorum vaginatum–Picea mariana*	Lowland Tussock Scrub Bog
	Lacustrine	Organic Loamy	Lacustrine or Shore Fen	Lake Margin	Poor	Absent	Wet Graminoid	*Carex rostrata–Carex aquatilis Eriophorum angustifolium–Carex aquatilis*	Lacustrine Fen Meadow
		Loamy	Lacustrine	Basin	Somewhat Well	Absent	Moist Graminoid	*Calamagrostis canadensis*	Lacustrine Moist Meadow
		Water	Deep Isolated Lake, Thaw and Kettle Lakes Shallow Isolated Ponds, Thaw and Kettle Lakes	Water	Flooded	Absent	Open Water	*Water*	Ponds and Lakes
							Aquatic Herbaceous	*Potamogeton alpinus–Nuphar polysepalum*	

Table 3 *(cont'd)*.

Climate	*Physiography*	*Soil Texture*	*Geomorphic Unit*	*Slope Position*	*Drainage*	*Permafrost*	*Vegetation* *Structure**	*Vegetation* *Indicator Species†*	*Ecosystem Class*
Boreal (cont'd)	Riverine	Rocky	Glacial Outwash Riverbed, Glacial Outwash Inactive Riverbed	Flat	Excessive	Absent	Barren	Barren and Partially Vegetated	Riverine Gravelly Barrens
							Dry Graminoid	*Agropyron* spp.–*Oxytropis campestris–Fragaria virginiana*	Riverine Gravelly Dry Meadow
							Dwarf Scrub	*Dryas drummondii –Populus balsamifera*	Riverine Gravelly Dry Dwarf Scrub
							Low and Tall Scrub	*Elaeagnus commutata–Potentilla multifida*	Riverine Gravelly Dry Low and Tall Scrub
							Broadleaf Forest	*Populus balsamifera– Fragaria virginiana*	Riverine Gravelly Dry Broadleaf Forest
							Mixed Forest	*Populus balsamifera–Picea glauca–Fragaria virginiana*	Riverine Gravelly Dry Mixed Forest
							Needleleaf Forest	*Picea glauca–Hylocomium splendens*	Riverine Gravelly Needleleaf Forest
		Loamy or Sandy	Glacial Outwash Inactive Floodplain,	Flat	Well	Absent	Needleleaf Forest	*Picea glauca–Alnus crispa* *Picea glauca–Hylocomium splendens*	Riverine Moist Needleleaf Forest
			Meandering Inactive Floodplain,				Mixed Forest	*Populus balsamifera–P. glauca–Rosa acicularis* *Betula papyrifera-P. mariana-Ledum groenlandicum*	Riverine Moist Mixed Forest
			Headwater Inactive Floodplain Stream				Broadleaf Forest	*Populus tremuloides–P. balsamifera–Linnea borealis* *Populus balsamifera–Picea glauca–Elymus innovatus*	Riverine Moist Broadleaf Forest
							Tall Scrub	*Alnus crispa–Empetrum nigrum*	Riverine Moist Tall and Low Scrub
							Low Scrub	*Betula nana–Salix pulchra* *Salix pulchra–Calamagrostis canadensis*	
					Poor	Present	Wet Graminoid	*Eriophorum angustifolium–Salix spp.*	Riverine Wet Meadow
			Alluvial Fan	Upper	Excessive	Absent	Tall Scrub	*Alnus crispa–Calamagrostis canadensis*	Riverine Moist Tall Scrub
	Rivers	Water	Upper Perennial Glacial and Non-glacial River	River	Flooded	Absent	Water	Water	Upper Perennial River

*Vegetation structure based on Alaska Vegetation Classification (Viereck et al. 1992): Level 2 for trees and shrubs and Level 3 for herbaceous.
†Indicator species are the dominant and differentiating species.

The main disadvantage to this integrated approach is that physiography or slope position is scale dependent (e.g., a small raised area seen on the ground may function as an upland even though it occurs within a broad lowland area), and this contributes to uncertainty in classification and mapping. This problem with differentiation of physiography is similar to that associated with the hydrogeomorphic classes (e.g., slopes, depressions, flats) developed by Brinson (1993). A second disadvantage is that the grouping of the many ecological components can generate a large number of classes. For practical purposes, the number of classes needs to be reduced by combining similar characteristics and ignoring unusual plots that do not fit the simplified trends.

Ecotypes

Classification and mapping

Field data from ground-reference plots were used to identify 48 ecotype classes within Fort Greely (Table 4, Fig. 8 and 9, Appendix B). Of these, 37 classes were differentiated in the final map (Fig. 10). The 11 classes that were not mapped were not spectrally distinct enough or large enough to map reliably. For example, low and tall scrub classes were merged for mapping in some upland areas, and Lowland Fen Meadow, Lacustrine Fen Meadow, and Lowland Dwarf Scrub Bog were merged with the nearest similar class because they were not spectrally distinct.

The map revealed a high diversity of ecotypes resulting from the strong elevation gradient and diversity of geomorphic processes. Overall, the most abundant ecotypes were Lowland Tussock Scrub Bog, Lowland Wet Low Scrub, and Lowland Wet Needleleaf Forest (Table 5). Unusual ecotypes found on Fort Greely that are relatively rare elsewhere in interior Alaska included Lowland Gravelly Dry Broadleaf Forest, Riverine Gravelly Dry Dwarf Scrub, and Riverine Gravely Dry Meadow, which were associated with dry outwash gravels; Upland Rocky Dry Low Scrub, which was associated with dry gravelly moraines; and Lowland Dwarf Scrub Bog, which was associated with thick organic deposits.

Although we initially used the Alaska Vegetation Classification (AVC) for vegetation types, it generated a large number of classes because of changes in the canopy coverage (open, closed, and woodland) of trees and shrubs. In many cases, such as for black spruce types, the understory vegetation was similar among classes. Similarly, small changes in tree composition generated numerous deciduous and mixed forest classes. We avoided this proliferation of vegetation classes primarily by relying on the upper levels of the AVC that characterize plant structure. We then relied on physiographic and soil attributes associated with geomorphology, along with the plant structure, to help differentiate species composition.

Accuracy assessment

Our assessment revealed that the overall accuracy of the final ecotype map with 37 classes was 47% (Appendix C). The errors fell into three major categories. First, there was substantial confusion between Lowland Wet Low Scrub and Lowland Tussock Scrub Bog because spectral classification discriminated poorly between low scrub alone and low scrub with tussocks, and because differentiation also was difficult on the ground. In our study, we used a cutpoint of 20% cover of *Eriophorum vaginatum* for the tussock class, though others use cover values as low as 12%. Secondly, it was difficult to assign upland and lowland physiography to map classes. This confusion is largely a question of scale; small patches of upland within a larger lowland region often were called upland on the ground, but mapped as lowland. Finally, the last type of large error was attributable to a lack of data describing soil texture and moisture. While including these descriptors as part of the ecotype classification provides valuable information, it adds complexity to the classification that can only be reduced by a very large ground verification effort.

Because the accuracy was poor for the map with the 37 ecotypes, we derived another map with 20 classes by aggregating similar classes that were prone to large error (Appendix D). Map accuracy for the 20 aggregated ecotypes was 70% (Table A7). This aggregated map still includes sufficient discrimination of ecosystem properties for many management objectives, and also provides an example of the derivative products possible through manipulation of the map database.

This accuracy assessment, however, does not represent the "true" map accuracy because the comparison was made with ground-reference data used in the map production and not with independent data. Thus, it may be biased toward a result of higher accuracy because the plots were used to develop map classes. Conversely, the results may be biased toward a poorer accuracy because ground plots often were located in small ecotype patches and this probably increased errors associated with co-registration of plot and map data. Most accuracy assessments focus the sampling on large homogenous patches, which tends to artificially increase map accuracy. Without an independent assessment, the true accuracy is unknown, yet we believe that our pseudo-accuracy results are consistent with our knowledge of the study area and the problems we encountered during mapping.

Table 4. Classification and description of ecotypes within Fort Greely. Descriptions include physiography, geomorphology, soil properties, and vegetation. Plant names in bold are indicator species that can be used to differentiate ecotypes on the ground.

Class	*Description*
Alpine Rocky Dry Barrens	Rugged, unvegetated or partially vegetated (<30% cover) areas above treeline (~900 m) with exposed bedrock or unstable talus slopes. Soils are rocky, lacking in organics, excessively drained, dry, and slightly acidic (pH 6.1–6.5). Permafrost usually is present but hard to detect because of rocky soils. Pioneering plants include *Dryas octopetala, Salix arctica, Racomitrium lanuginosum, Stereocaulon* sp., and crustose lichens.
Alpine Rocky Dry Dwarf Scrub	Rugged terrain above treeline on weathered bedrock or talus with vegetation dominated by dwarf (0.2-m) evergreen shrubs. Soils are rocky, lacking in organics, excessively drained, dry, and strongly (pH 5.1–5.5) acidic. Permafrost usually is present but hard to detect because of rocky soils. Dominant plants include ***Dryas octopetala****, Vaccinium uliginosum, Cassiope tetragona, Oxytropis nigrescens,* ***Hierochloe alpina****, Stereocaulon* sp.*,* and other lichens.
Alpine Rocky Moist Low Scrub	Rugged terrain above treeline on weathered bedrock or talus with vegetation dominated by low (0.2–1.5 m) deciduous shrubs. Soils generally are rocky, usually moist but including wet areas in drainages, and strongly acidic. Dominant plants include ***Alnus crispa, Betula nana****, V. uliginosum, Empetrum nigrum, Calamagrostis canadensis,* ***Epilobium angustifolium****,* and *Hylocomium splendens*. Shrubs can be taller in drainages.
Alpine Wet Tussock Meadow	Lower slopes and plateaus above treeline on retransported deposits and colluvium with vegetation dominated by tussocks and low shrubs. Soils are loamy with moderately (20–40 cm) thick organic layers, poorly drained, wet, and strongly acidic. Permafrost is present and thaw depths are shallow. Dominant plants include ***Eriophorum vaginatum****, V. uliginosum,* ***Carex bigelowii***, *B. nana, E. nigrum,* and *Sphag-num* spp. Lacks *Picea mariana*.
Alpine Wet Low Scrub	Lower slopes above treeline and headwater floodplains with vegetation dominated by low shrubs. Soils are loamy with moderately thick organic layers, poorly drained, wet, and moderately acidic (5.6–6). Permafrost is present and thaw depths are shallow. Dominant plants include ***Betula nana***, *Vaccinium uliginosum,* ***Carex bigelowii****, Ledum decumbens*, *Vaccinium vitis-idaea, Empetrum nigrum, Pleurozium schreberi,* and *Sphagnum* spp.
Alpine Wet Meadow	Swales, water tracks, and headwater floodplains above treeline with vegetation dominated by sedges. Soils are loamy or organic, saturated, and slightly (pH 6.1–6.5) acidic. Permafrost is present and thaw depths are shallow. Dominant plants include ***Eriophorum angustifolium, Carex aquatilis,*** *Carex canescens, Salix planifolia, Potentilla palustris*, and *Sphagnum* spp. Uncommon and not mapped.
Upland Rocky Dry Meadow	Steep, south-facing bluffs with vegetation dominated by herbs and shrubs. Soils are rocky (angular weathered bedrock), lacking in organics, excessively drained, dry, and neutral (6.6–7.3) to slightly (7.4–7.8) alkaline. Some sites have moderate accumulations of loess. Permafrost is absent. Dominant plants include ***Artemisia frigida****, Calamagrostis purpurascens,* ***Juniperus communis****, Populus tremuloides, Rhytidium rugosum*, and lichens.
Upland Rocky Dry Broadleaf Forest	South-facing upper slopes and ridges on weathered bedrock and gravelly moraines with vegetation that is dominated (>25% cover) by broadleaf trees. Soils are rocky with only thin surface organic layers, well drained, dry, and moderately acidic. Permafrost is absent. Dominant plants include ***Populus tremuloides,*** *Shepherdia canadensis, V. vitis-idaea*, ***Arctostaphylos uva-ursi***, *Hylocomium splendens, Polytrichum* sp., and lichens.
Upland Rocky Dry Low Scrub	Upper slopes on weathered bedrock and gravelly moraines with vegetation that is dominated by low shrubs and lichens. Soils are rocky with only thin surface organic layers, well-drained, dry, and slightly acidic. Permafrost is absent. Dominant plants include ***Betula nana****, Alnus crispa, V. uliginosum, Arctostaphylos alpina,* ***Stereocaulon* sp.,** and *Polytrichum* sp. Scattered dwarf *P. mariana* and prostrate dwarf *Populus tremuloides* often are present
Upland Moist Meadow	Upper slopes on loess and weathered bedrock with vegetation dominated by grasses and herbs. Soils are rocky to loamy, well drained, moist, and strongly acidic. Older sites are dominated by ***Calamagrostis canadensis*** and younger, recently burned sites are dominated by early successional species including ***Epilobium angustifolium****, Salix bebbiana*, and *Betula papyrifera* saplings. Uncommon and not mapped.
Upland Moist Low and Tall Scrub	Upper slopes on loess and moraine deposits with vegetation dominated by low and tall shrubs. Soils are loamy with moderately thin organic layers, somewhat well drained, moist, and strongly acidic. Permafrost usually is absent. Dominant plants include ***Alnus crispa***, ***Betula nana****, Vaccinium uliginosum,* ***Salix planifolia****, S. glauca, V. vitis-idaea,* and *Calamagrostis canadensis.*
Upland Moist Low and Tall Scrub—disturbed	Upper slopes of loess and moraine deposits with early successional vegetation dominated by low and tall shrubs. Disturbance most commonly is from fire. Soils are loamy to rocky, well drained, and moder-ately acidic. Dominant plants include ***Epilobium angustifolium, Vaccinium uliginosum****, Betula nana, Populus tremuloides* saplings*, Ledum groenlandicum*, and *Polytrichum* sp.

Table 4 *(cont'd)*. Classification and description of ecotypes within Fort Greely. Descriptions include physiography, geomorphology, soil properties, and vegetation. Plant names in bold are indicator species that can be used to differentiate ecotypes on the ground.

Class	*Description*
Upland Moist Broadleaf Forest	Gentle upper slopes on loess and moraine deposits with vegetation dominated by deciduous broadleaf trees. Soils are loamy with thin surface organic layers, well drained, moist, and moderately acidic. Permafrost is absent. The closed canopy is dominated by ***Betula papyrifera***, while *Alnus crispa, Picea glauca, P. mariana, Rosa acicularis,* ***Calamagrostis canadensis,*** and *Hylocomium splendens* are important in the understory.
Upland Moist Mixed Forest	Upland slopes on loess, residual soils, and moraines with vegetation dominated by mixed forests. Soils are loamy (sometimes gravelly) with thin surface organic layers, well drained, moist, and moderately acidic. Permafrost is absent. The canopy is dominated by ***Picea glauca*** and ***Betula papyrifera*** while other important plants include *Populus tremuloides, Picea mariana, Geocaulon lividum,* ***Linnaea borealis****,* and *Hylocomium splendens*.
Upland Moist Needleleaf Forest	Upland slopes on loess, residual soils, and moraines with vegetation dominated by needleleaf forests. Soils are loamy (sometimes gravelly) with thin surface organic layers, well-drained, moist, and moderately acidic. Permafrost is absent. The canopy is dominated by ***Picea glauca*** and common understory species include ***Alnus crispa****, Rosa acicularis, Geocaulon lividum*, and *Hylocomium splendens.*
Upland Wet Needleleaf Forest	Steep, upper north-facing slopes on loess, residual soils, and moraines with vegetation dominated by needleleaf forests. Soils are organic to loamy, poorly drained because of the presence of permafrost, wet to moist, and moderately acidic. Moisture is variable because bedrock may be near the surface and permafrost may be absent. Canopy is dominated by ***Picea mariana*** and understory plants include *Alnus crispa,* ***Ledum groenlandicum****, Vaccinium vitis-idaea, Hylocomium splendens*, *Pleurozium schreberi*, and *Sphagnum spp*.
Lowland Gravelly Moist Low Scrub	Low-lying, flat areas on abandoned floodplains and terraces of glacial outwash with vegetation dominated by low shrubs. Soils are gravelly with thin organic and loam horizons, well to excessively drained, dry, and slightly acidic. Vegetation is dominated by ***Betula nana*** and ***Stereocaulon*** sp., and includes *Picea mariana*, dwarf *Populus tremuloides, Vaccinium vitis-idaea,* and *Hylocomium splendens*.
Lowland Gravelly Dry Broadleaf Forest	Low-lying, flat areas on glacial outwash and thin loess deposits with vegetation dominated by broadleaf forests. Soils are gravelly with little surface organics, well to excessively drained, dry, and slightly acidic. Permafrost is absent. The canopy is dominated by ***Populus tremuloides*** and occasionally mixed with *P. balsamifera*. The understory usually includes *P. mariana,* ***Arctostaphylos uva-ursi****, Festuca altaica,* and *Galium boreale*.
Lowland Gravelly Dry Mixed Forest	Low-lying, flat areas on abandoned floodplains and terraces of glacial outwash with vegetation dominated by mixed forests. Soils are gravelly with thin organic and loam horizons, well to excessively drained, dry, and slightly acidic. Canopy is co-dominated by ***Picea glauca, P. tremuloides*** and *P. balsamifera,* and the understory includes ***Shepherdia canadensis****, Linnaea borealis*, and *Hylocomium splendens*. Uncommon and not mapped.
Lowland Gravelly Needleleaf Forest	Low-lying, flat areas on abandoned floodplains and terraces of glacial outwash with vegetation dominated by needleleaf forests. Soils are gravelly with moderately thick organic and loam horizons, well to excessively drained, dry, and slightly acidic. Tree canopy may be dominated by either ***Picea glauca*** or ***P. mariana***, common associates include *Vaccinium uliginosum, V. vitis-idaea,* ***Stereocaulon*** sp., and *Rhytidium rugosum*.
Lowland Moist Meadow	Low-lying areas or basins formed in drained lakes in moraines and abandoned floodplains with vegetation dominated by sedges and grasses. Soils are loamy with organic horizons of variable depth, somewhat well-drained, moist, and slightly acidic. Dominant plants include ***Carex saxatilis*** and/or *Calamagrostis canadensis*, associated species may include *Eriophorum angustifolium, C. aquatilis*, and *Salix arbusculoides*. Not mapped.
Lowland Low Scrub—disturbed	Lower slopes and flat, low-lying areas on moraines and glaciofluvial outwash deposits with early successional vegetation dominated by low shrubs. Disturbance most commonly is from fire. Sites are loamy or rocky with thin organic horizons, well drained, and slightly acidic. Common plants include ***Vaccinium uliginosum****, Betula nana, Ledum groenlandicum*, ***Epilobium angustifolium****, Salix glauca, V. vitis-idaea, Ceratodon purpureus,* and *Polytrichum* sp.
Lowland Moist Tall Scrub	Lower slopes and flat, low-lying areas on moraines, glaciofluvial outwash, and retransported deposits with vegetation dominated by tall shrubs. Soils are loamy with thin surface organic layers, well drained, moist, and moderately acidic. The open or closed shrub canopy is dominated by ***Alnus crispa*** or *Salix bebbiana,* and usually includes ***Salix planifolia****,* ***Calamagrostis canadensis****,* and *Betula nana*.

Table 4 *(cont'd)*.

Class	*Description*
Lowland Wet Broadleaf Forest	Flat to gently sloping low-lying areas on lowland loess, abandoned floodplains, and retransported deposits with vegetation dominated by broadleaf trees. Soils are loamy with thin surface organic layers, poorly drained because of permafrost, and wet, and have neutral pH and slightly elevated electrical conductivities indicative of groundwater movement. The closed or open canopy is dominated by ***Betula papyrifera*** and understory species include *Picea glauca, Rosa acicularis, Salix bebbiana, Calamagrostis canadensis*, and ***Equisetum sylvaticum***.
Lowland Wet Mixed Forest	Flat to gently sloping low-lying areas on lowland loess, abandoned floodplains, and retransported deposits with vegetation dominated by mixed forests. Soils are loamy with moderately thick surface organic horizons, poorly drained because of permafrost, wet, and moderately acidic. The forest canopy is co-dominated by ***Betula papyrifera*** and ***Picea mariana*** (occasionally *P. glauca).* Common understory species include *Alnus crispa, Rosa acicularis,* ***Calamagrostis canadensis***, *Equisetum sylvaticum,* and *Hylocomium splendens.*
Lowland Wet Needleleaf Forest	Flat to gently sloping low-lying areas on lowland loess, abandoned floodplains, and retransported deposits with vegetation dominated by needleleaf trees. Soils are loamy with moderately thick surface organic horizons, poorly drained because of permafrost, wet, and moderately acidic. Dominant plants include ***Picea mariana, Ledum groenlandicum***, *Betula nana, Vaccinium uliginosum, V. vitis-idaea*, ***Rubus chamaemorus***, *Hylocomium splendens, Sphagnum* spp., and *Pleurozium schreberi*.
Lowland Wet Low Scrub	Flat to gently sloping low-lying areas on lowland loess, abandoned floodplains, and retransported deposits with vegetation dominated by low shrubs. Soils are loamy with moderately thick surface organic horizons, poorly drained because of permafrost, wet, and moderately acidic. Common plants include ***Betula nana***, *Vaccinium uliginosum,* ***Picea mariana***, *Salix planifolia, Ledum groenlandicum, Rubus chamaemorus, Hylocomium splendens*, and *Sphagnum* spp.
Lowland Tussock Scrub Bog	Flat to gently sloping low-lying areas on lowland loess, abandoned floodplains, and retransported deposits with vegetation dominated by sedge tussocks. Soils are organic (>40 cm) or loamy with thick organic layers, poorly drained because of permafrost, wet, and strongly acidic. Dominant plants include ***Eriophorum vaginatum, Picea mariana***, *B. nana, V. uliginosum, L. decumbens, Empetrum nigrum, Rubus chamaemorus,* and *Sphagnum spp*.
Lowland Dwarf Scrub Bog	Flat to gently sloping low-lying areas on lowland loess, abandoned floodplains, and retransported deposits with vegetation dominated by dwarf shrubs. Soils are organic (>40 cm), poorly drained due to permafrost, wet, and strongly acidic. Vegetation is dominated by ***Rubus chamaemorus*** and ***Sphagnum*** *spp*. and includes *P. mariana, L. decumbens, E. nigrum,* ***Oxycoccus microcarpus***, and *Andromeda polifolia*. Uncommon and not mapped.
Lowland Fen Meadow	Low-lying swales on retransported deposits, lowland loess, and abandoned floodplains with vegetation dominated by sedges. Soils are organic, saturated with water near the surface, and weakly minerotrophic (poor fens) due to groundwater movement. Dominant plants include ***Eriophorum angustifolium***, *Carex aquatilis, Betula nana, Vaccinium uliginosum*, and ***Sphagnum*** spp. Uncommon and not mapped.
Lacustrine Moist Meadow	Basins in fine-grained lacustrine deposits with vegetation dominated by grasses. Soils are loamy, somewhat well drained, moist, and usually mottled at depth. Permafrost is absent. Vegetation is dominated by ***Calamagrostis canadensis,*** and frequently includes *Salix bebbiana, S. planifolia*, or *Betula nana*.
Lacustrine Fen Meadow	Basins or pond margins with vegetation dominated by sedges. Soils have well-developed fibric sedge peat over fine-grained lacustrine deposits (shore fens), and are saturated to the surface and slightly acidic. Permafrost is absent. Common plants include ***Carex aquatilis, C. rostrata***, *C. canescens, Eriophorum angustifolium, Equisetum fluviatile*, and *Hippuris vulgaris*. Not mapped because spectrally indistinct.
Ponds and Lakes	Lacustrine waterbodies with or without emergent or floating vegetation. Lakes are associated with thaw basins formed by permafrost degradation and kettle depressions formed by melting of glacial ice in moraines. Water usually is deep (>1.5 m) and does not freeze to the bottom during the winter. Common plants include *Potamogeton alpinus, P. foliosus, P. gramineus, Nuphar polysepalum*, and *Isoëtesmuricata*
Riverine Gravelly Barrens	Flat, barren areas on active riverbed gravels adjacent to rivers that are inundated frequently. Soils range from dry to wet. Surface is nearly free of vegetation (<30% cover), or colonized by pioneer vegetation in less frequently flooded areas. Pioneer species include *Potentilla multifida, Agropyron pauciflorum, Elaeagnus commutata, Dryas drummondii*, and *Oxytropis campestris.*
Riverine Gravelly Low and Tall Scrub	Flat, less-frequently flooded areas on inactive glaciofluvial outwash deposits with vegetation dominated by low and tall shrubs. Soils are stratified to massive gravel with occasional thin and sandy layers, lacking in organics, excessively drained, dry, and slightly acidic. The early successional vegetation is highly variable, and frequently includes ***Elaeagnus commutata***, *Potentilla multifida, Populus balsamifera* saplings, *Salix alaxensis, Potentilla fruticosa, Oxytropis campestris*, and occasionally *Alnus tenuifolia*. Uncommon and not mapped.

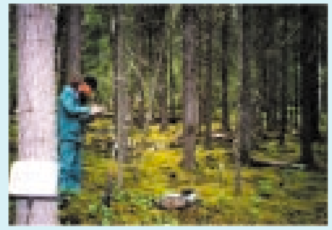
Table 4 *(cont'd)*. Classification and description of ecotypes within Fort Greely. Descriptions include physiography, geomorphology, soil properties, and vegetation. Plant names in bold are indicator species that can be used to differentiate ecotypes on the ground.

Class	*Description*
Riverine Gravelly Dry Dwarf Scrub	Flat, less-frequently flooded areas on inactive glaciofluvial outwash deposits with vegetation dominated by dwarf shrubs. Soils are stratified to massive gravel with occasional thin sandy layers, lacking in organics, excessively drained, dry, and slightly alkaline. Early successional vegetation includes ***Dryas drummondii****, Populus balsamifera* saplings, *Shepherdia canadensis, Fragaria virginiana*, and ***Oxytropis campestris***.
Riverine Gravelly Dry Meadow	Flat areas on inactive glaciofluvial outwash deposits with vegetation dominated by grasses and forbs. Flooding is infrequent and soils are gravelly, excessively drained, dry, and neutral. Common plants include ***Oxytropis campestris, Fragaria virginiana***, and ***Agropyron*** spp. Uncommon and not mapped.
Riverine Gravelly Dry Broadleaf Forest	Flat areas on inactive glaciofluvial outwash deposits with vegetation dominated by broadleaf trees. Flooding is infrequent. Soils have interbedded gravel, sand and silt, lack organics, and are excessively drained, dry, and neutral. The open to closed canopy is dominated by ***Populus balsamifera*** and the understory includes *Picea glauca, Shepherdia canadensis, P. fruticosa, Dryas drummondii,* ***Fragaria virginiana***, and *Elymus innovatus*.
Riverine Gravelly Dry Mixed Forest	Flat areas on inactive glaciofluvial outwash deposits with vegetation dominated by mixed broadleaf and needleleaf trees. Flooding is infrequent. Soils have interbedded gravel, sand and silt, lack organics, and are excessively drained, dry, and neutral. This intermediate successional stage between broadleaf and needleleaf forest has a closed canopy dominated by ***Populus balsamifera*** and ***Picea glauca,*** and the understory includes *Shepherdia canadensis, Dryas drummondii,* ***Fragaria virginiana,*** and *Ceratodon purpureus*. Not mapped.
Riverine Gravelly Needleleaf Forest	Flat areas on inactive glaciofluvial outwash deposits with vegetation dominated by needleleaf trees. Deposits have interbedded gravel, sand and silt layers, with thin surface organic layers, indicative of frequent flooding. Soils are excessively drained, dry, and slightly acidic. This late-successional vegetation type has an open to closed canopy dominated by ***Picea glauca,*** and the understory includes ***Shepherdia canadensis****, Solidago canadensis*, *Geocaulon lividum* and *Hylocomium splendens*
Riverine Moist Low and Tall Scrub	Flat areas on inactive floodplains of meandering and headwater streams with vegetation dominated by low and tall shrubs. Soils have interbedded silts and sands with thin surface organic layers, and are well drained, moist, and slightly acidic. Common species include ***Alnus tenuifolia, Salix planifolia****, Betula nana,* and ***Calamagrostis canadensis***.
Riverine Moist Broadleaf Forest	Flat areas on inactive floodplains of meandering and headwater streams with vegetation dominated by broadleaf trees. Soils have interbedded silts and sands with thin surface organic layers, and are well drained, moist, and slightly acidic. Vegetation is dominated by ***Populus balsamifera*** (occasionally mixed with *P. tremuloides*) and the understory includes *Dryas drummondii, Astragalus* spp., *Geocaulon lividum*, and *Linnaea borealis*.
Riverine Moist Mixed Forest	Flat areas on inactive floodplains of meandering and headwater streams with vegetation dominated by broadleaf trees. Soils have interbedded silts and sands with thin surface organic layers, and are well drained, moist, and slightly acidic. The closed canopy is dominated by ***Betula papyrifera*** or ***P. balsamifera*** and ***Picea glauca,*** and the understory has *Alnus tenuifolia,* ***Rosa acicularis****, G. lividum, L. borealis*, and *Hylocomium splendens*.
Riverine Moist Needleleaf Forest	Flat areas on inactive floodplains of meandering and headwater streams with vegetation dominated by needleleaf trees. Soils have interbedded silts and sands with thin surface organic layers, and are well drained, moist, and slightly acidic. The open to closed canopy is dominated by ***Picea glauca*** and the understory includes ***Rosa acicularis****, Ledum groenlandicum, Calamagrostis canadensis*, and *Hylocomium splendens*.
Riverine Wet Meadow	Flat areas on inactive floodplains of headwater streams with vegetation dominated by sedges. Soils have interbedded silts and sands with a thick surface organic layer, and are saturated near the surface. Vegetation is dominated by ***Carex aquatilis*** and *Eriophorum angustifolium,* and also includes *Myrica gale, Salix planifolia*, and *Chamaedaphne calyculata*. Uncommon and not mapped.
Upper Perennial River	Braided and meander rivers relatively close to the headwaters. Includes both glacial, nonglacial clearwater, and nonglacial blackwater (high in humics and tannins) rivers and streams. In larger rivers, water flows throughout the year in deep channels. Water body types are differentiated by geomorphic units on ecosection map. All mapped rivers on the ecotype map are glacial.
Human Disturbed Scrub	Revegetated clearings or areas where vegetation is managed by human activity. Human management includes brush cutting to maintain vegetation height and landscaping; areas include drop zones, roadsides, and landscaped portions of the cantonment area. Vegetation varies from species found in undisturbed low scrub communities to introduced grasses and weedy species.
Human Disturbed Barrens	Barren or partially (<30% cover) vegetated areas that have been disturbed by human activity. Clearings, airstrips and roads, and buildings are included in this class. Partially vegetated areas have pioneering indigenous species or introduced weedy species.

Alpine, Upland, Gravelly Lowland, and Lacustrine Ecotypes


Alpine Rocky Dry Barrens


Alpine Wet Tussock Meadow

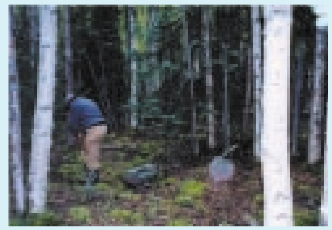

Upland Moist Needleleaf Forest


Upland Wet Needleleaf Forest


Lowland Gravelly Needleleaf Forest


Alpine Rocky Dry Dwarf Scrub


Alpine Wet Meadow


Upland Moist Broadleaf Forest


Upland Rocky Dry Broadleaf Forest

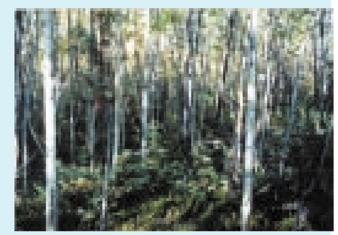

Lowland GravellyDry Mixed Forest

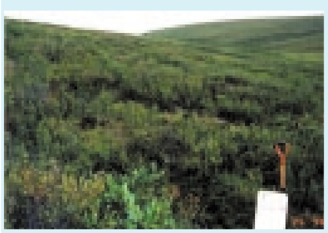

Alpine Rocky Moist Low Scrub


Lacustrine Fen Meadow


Upland Moist Low and Tall Scrub


Upland Rocky Dry Low Scrub


Lowland Gravelly Broadleaf Forest


Alpine Wet Low Scrub


Lacustrine Moist Meadow


Upland Moist Low and Tall - Disturbed


Upland Rocky Dry Meadow


Lowland Gravelly Moist Low Scrub

Figure 8. Ground views of alpine, upland, gravelly lowland, and lacustrine ecotypes on Fort Greely.

Lowland, and Riverine Ecotypes

Figure 9. Ground views of lowland and riverine ecotypes on Fort Greely.

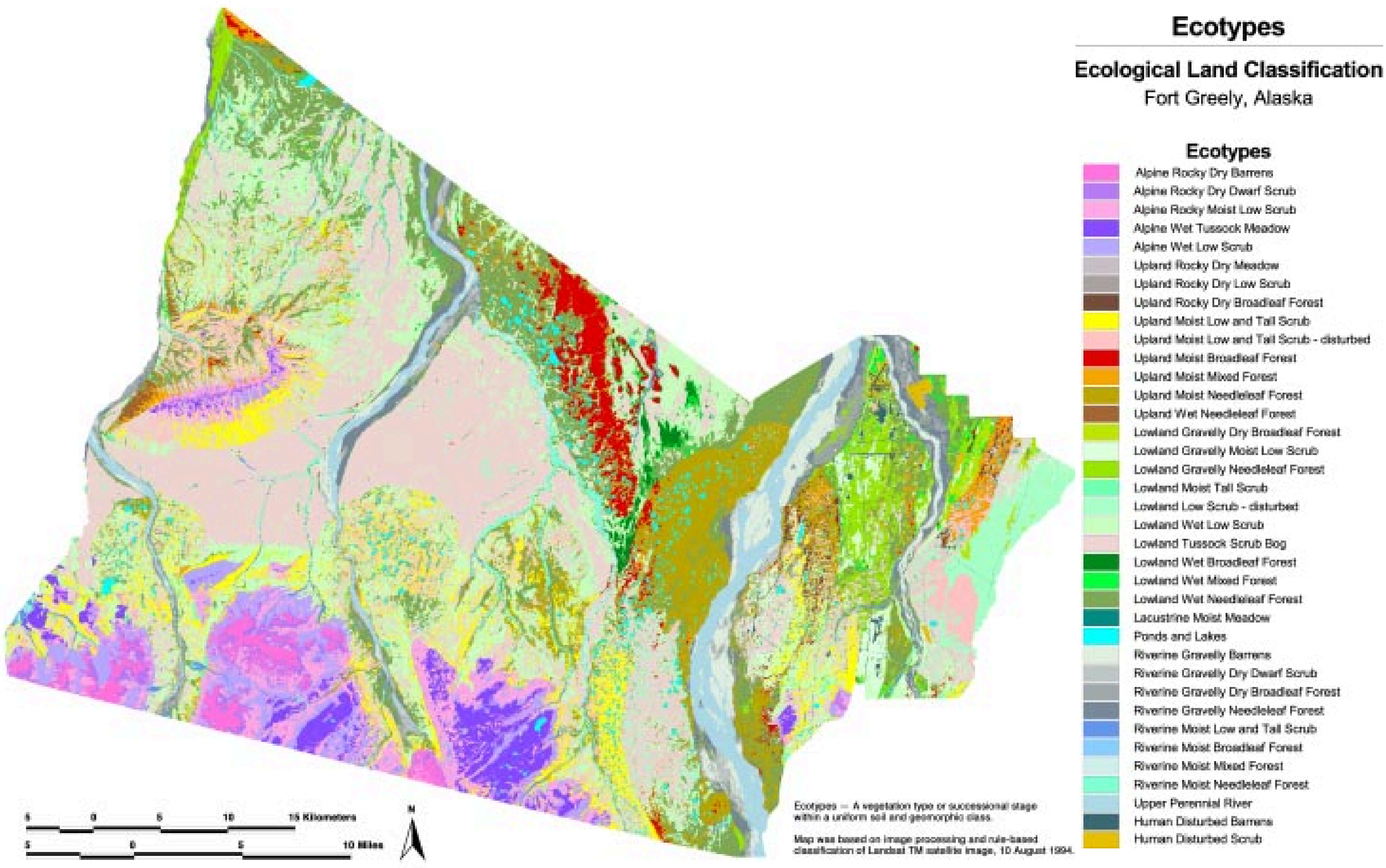


Figure 10. Ecotypes on Fort Greely.

Table 5. Areal extents of ecotypes found within Fort Greely.

	Area	
Ecotype	*ha*	*%*
Alpine Rocky Dry Barrens	3,378	1.3
Alpine Rocky Dry Dwarf Scrub	2,659	1.0
Alpine Rocky Moist Low Scrub	10,570	4.1
Alpine Wet Tussock Meadow	6,698	2.6
Alpine Wet Low Scrub	8,139	3.1
Upland Rocky Dry Meadow	38	<0.1
Upland Rocky Dry Low Scrub	782	0.3
Upland Rocky Dry Broadleaf Forest	815	0.3
Upland Moist Low and Tall Scrub	13,233	5.1
Upland Moist Low and Tall Scrub - disturbed	10,455	4.0
Upland Moist Broadleaf Forest	5,462	2.1
Upland Moist Mixed Forest	4,938	1.9
Upland Moist Needleleaf Forest	12,401	4.8
Upland Wet Needleleaf Forest	509	0.2
Lowland Gravelly Dry Broadleaf Forest	947	0.4
Lowland Gravelly Moist Low Scrub	6,339	2.4
Lowland Gravelly Needleleaf Forest	5,896	2.3
Lowland Moist Tall Scrub	865	0.3
Lowland Low Scrub - disturbed	9,467	3.6
Lowland Wet Low Scrub	36,136	13.9
Lowland Tussock Scrub Bog	55,133	21.2
Lowland Wet Broadleaf Forest	985	0.4
Lowland Wet Mixed Forest	2,021	0.8
Lowland Wet Needleleaf Forest	29,967	11.5
Lacustrine Moist Meadow	6	<0.1
Ponds and Lakes	3,044	1.2
Riverine Gravelly Barrens	4,876	1.9
Riverine Gravelly Dry Dwarf Scrub	1,899	0.7
Riverine Gravelly Dry Broadleaf Forest	4,044	1.6
Riverine Gravelly Needleleaf Forest	4,119	1.6
Riverine Moist Low and Tall Scrub	1,263	0.5
Riverine Moist Broadleaf Forest	135	0.1
Riverine Moist Mixed Forest	688	0.3
Riverine Moist Needleleaf Forest	2,548	1.0
Upper Perennial River	8,106	3.1
Human Disturbed Barrens	1,115	0.4
Human Disturbed Scrub	556	0.2
Total	260,234	100

Ecotype characteristics

Vegetation.The following discussion highlights some of the similarities and differences in species composition among ecotypes. Ecotypes were grouped successively by physiography, soil texture and moisture, and vegetation structure to help us compare species composition (Table 6).

Alpine ecotypes were either rocky or mixed texture classes. Ecotypes with exposed, dry rocky soils were dominated by *Dryas octopetala, Arctostaphylos alpina, Vaccinium uliginosum, Cassiope tetragona, Oxytropis nigrescens, Hierochloe alpina, Stereocaulon* spp., and other lichens (Table 6a). Wetter ecotypes on loamy or organic soils were dominated by *Betula nana, Eriophorum vaginatum, V. uliginosum, Ledum decumbens*, *Carex bigelowii*, *Empetrum nigrum,* and *Sphagnum* spp. In areas with water near the surface, *Eriophorum angustifolium, Carex aquatilis, Carex canescens, Salix planifolia, Potentilla palustris*, and *Sphagnum* spp. were important.

In upland areas, there also were large differences in the floristics between dry rocky soils and moist loamy soils, but floristics were similar among forest types, with differences mostly occurring only in dominance of tree species (Table 6b). Steep, rocky bluffs were dominated by *Artemisia frigida, Calamagrostis purpurascens, Juniperus communis,* and crustose lichens, whereas less exposed dry sites were dominated by *Populus*

Table 6. Mean cover (%) of the most abundant species within ecotypes on Fort Greely. (Blanks when absent, 0=<0.5%, bold signifies >60% frequency within ecotype.)

	Alpine Rocky Dry Barrens	Alpine Rocky Dry Dwarf Scrub	Alpine Rocky Moist Low Scrub	Alpine Wet Tussock Meadow	Alpine Wet Low Scrub	Alpine Wet Meadow
			a. Alpine.			
Diapensia lapponica	0	1				
Trisetum spicatum	0	0	0			
Artemisia arctica	0	1	1			
Saxifraga tricuspidata	1	0	0			
Racomitrium lanuginosum	3	1	1			
Rhytidium rugosum	1	1	1			
Calamagrostis purpurascens	3		1			
Stereocaulon spp.	**1**	**4**	2			
Saxifraga punctata	0	**0**				
Oxytropis nigrescens	1	**2**				
Cetraria islandica	0	**0**	0			
Cetraria nivalis	0	**1**	0			
Hierochloe alpina	0	**2**	0			
Arctostaphylos alpina	0	**4**	1			
Salix arctica	1	**3**	1	0		
Dryas octopetala	5	**25**	1	2		
Cassiope tetragona		**4**	1			
Cetraria cucullata	0	**1**	1	1	1	
Salix glauca	1		7			
Lichen	1	10	2	0	1	1
Hylocomium splendens	0	0	**7**	1	8	
Alnus crispa	0		**21**		5	
Epilobium angustifolium		0	**3**			
Vaccinium uliginosum	0	**4**	**10**	**14**	**15**	8
Vaccinium vitis-idaea		1	**6**	**4**	**13**	
Empetrum nigrum		0	**6**	**11**	**10**	2
Betula nana		2	**20**	**9**	**46**	3
Carex bigelowii	1	1	2	**16**	**15**	
Ledum decumbens		0	4	**7**	**11**	5
Pleurozium schreberi			7	**4**	**15**	
Calamagrostis canadensis			8		1	1
Eriophorum vaginatum				**39**	**10**	1
Sphagnum spp.			2	**17**	**21**	20
Polytrichum spp.	1	2	0	**5**	**9**	**3**
Thamnolia spp.	0	1	0	**1**	1	
Ptilium crista-castrensis			1	0	8	
Cladina spp.	0	0	4	0	**1**	1
Dicranum spp.	1	0	1	2	**3**	3
Cladonia spp.	0	0	1	0	**1**	1
Aulacomnium turgidum		0	2	1	0	4
Polygonum bistorta		0	0	0	**1**	
Aulacomnium palustre			1	1	**2**	5
Cetraria sp.			0	1	**1**	1
Salix planifolia		0	14	3	**8**	**3**
Rubus chamaemorus			0	0	1	1
Carex aquatilis					2	**28**
Eriophorum angustifolium					1	**20**
Potentilla palustris						**1**
Arctophila fulva						13
Carex rostrata						5
Carex saxatilis						3
Eriophorum scheuchzeri						3
Carex canescens						2
Poa lanata	0	0				1
Andromeda polifolia				0	1	1
Dactylina spp.		0		0	0	1
Oxycoccus microcarpus				0	0	1
Arctagrostis latifolia		0			0	1
sample size	4	6	8	5	6	2

Table 6 *(cont'd)*. Mean cover (%) of the most abundant species within ecotypes on Fort Greely. (Blanks when absent, 0=<0.5%, bold signifies >60% frequency within ecotype.)

	Upland Rocky Dry Meadow	*Upland Rocky Dry Broadleaf Forest*	*Upland Rocky Dry Low Scrub*	*Upland Moist Low and Tall Scrub*	*Upland Moist Low and Tall Scrub-disturbed*	*Upland Moist Broadleaf Forest*	*Upland Moist Mixed Forest*	*Upland Moist Needleleaf Forest*	*Upland Wet Needleleaf Forest*
				b. Upland.					
Juniperus communis	**1**								
Crustose lichen	**17**								
Artemisia frigida	**10**								
Calamagrostis purpurascens	**7**	0	0						
Poa sp.	**1**		0						
Rhytidium rugosum	**4**	0	2	2				3	
Populus tremuloides	**2**	**27**	4	2	6	9	**23**	0	
Arctostaphylos uva-ursi		**8**	**3**	0	2	0			
Arctostaphylos alpina		1	**8**					0	
Cladina sp.		**3**	**6**	1		0		1	**1**
Stereocaulon sp.		13	**7**	0				3	
Peltigera canina		**1**	0	0				0	
Polytrichum sp.		**2**	**10**	1	7			0	**2**
Festuca altaica			1	2		0		0	
Betula nana		5	**24**	**25**	13			7	2
Vaccinium uliginosum		4	**11**	**8**	**12**			6	2
Salix planifolia			1	**5**					1
Salix glauca			1	**4**	1	0			
Cladonia sp.	3	1	3	1		0	3	2	**1**
Rosa acicularis	**2**	**1**	0	0	1	**8**	1	**2**	**4**
Epilobium angustifolium		**1**	1	1	**11**	0	**2**		
Peltigera aphthosa		**2**		1		0	**1**	1	**2**
Vaccinium vitis-idaea		**8**	**5**	**5**	2	**4**	5	3	**14**
Ledum decumbens		2	1	6				1	1
Picea mariana		**2**	**2**	1		13	13	8	**30**
Ledum groenlandicum		0	**3**	1	8	1	2	0	**27**
Alnus crispa			**12**	**23**	1	19	3	**8**	**17**
Calamagrostis canadensis		0	0	3	4	**19**		6	**13**
Betula papyrifera		17	3	2	3	**63**	**13**	3	**1**
Hylocomium splendens		**5**	1	13	5	**24**	**23**	**63**	**53**
Picea glauca	0	14	1	2	0	6	**27**	**35**	10
Linnaea borealis		1		0			**3**	1	
Geocaulon lividum		1	2	0			**4**	**4**	**2**
Dicranum sp.		0	0	1		0	0	1	**1**
Equisetum sylvaticum						3			**4**
Pleurozium schreberi		0	0	2				0	**10**
Sphagnum sp.				3					**22**
Petasites frigidus				1					**2**
Sample size	3	5	10	6	11	6	3	6	3

Table 6 *(cont'd)*.

	Lowland Grav. Dry Broadleaf Forest	*Lowland Gravelly Dry Mixed Forest*	*Lowland Gravelly Moist Low Scrub*	*Lowland Gravelly Needleleaf Forest*	*Lacustrine Moist Meadow*	*Lowland Moist Meadow*	*Lowland Low Scrub-disturbed*	*Lowland Moist Tall Scrub*	*Lowland Wet Broadleaf Forest*	*Lowland Wet Mixed Forest*	*Lowland Wet Needleleaf Forest*	*Lowland Wet Low Scrub*	*Lowland Tussock Scrub Bog*	*Lowland Dwarf Scrub Bog*	*Lowland Fen Meadow*	*Lacustrine Fen Meadow*
c. Lowland.																
Cnidium cnidiifolium	1															
Galium boreale	**2**						0	0								
Fragaria virginiana	8	1		0				0								
Juniperus communis		1		0												
Rhytidium rugosum		0		**4**												
Festuca altaica	**4**		1	0			4	2			0					
Shepherdia canadensis	2	**15**		4												
Arctostaphylos uva-ursi	**8**	4	1	2			2	0			1					
Populus tremuloides	**58**	**16**	**14**	3			2	1		1		0				
Stereocaulon sp.		1	**22**	**13**			1				1					
Populus balsamifera	20	**11**		0		0	1				0					
Lupinus arcticus	2		0				0	1			0					
Linnaea borealis		**2**		1			5		0		0					
Picea glauca	3	**25**	2	**21**	0		0	0	**5**	8	4	0				
Hylocomium splendens		**29**	9	**43**			1		**3**	19	23	10	0	1		
Cladina spp.	1			6			1				1	1	0	1		
Cladina arbuscula		3		2							0	0				
Geocaulon lividum		2		4							1					
Peltigera aphthosa	1	**1**		**2**			0			0	1	0	0			0
Salix bebbiana	3	**3**		1	3	0	1	10	13	3	0	1				
Ceratodon purpureus							**8**	4				0	0			
Epilobium angustifolium	5	1		1	0		**13**	3	0			0				
Salix glauca			1				**4**	3			0	1				
Polytrichum spp.			2	1	0	1	**14**	0	**1**		1	4	**4**		0	0
Carex saxatilis						**38**		0								2
Vaccinium vitis-idaea	5	6	11	**15**			**7**	0	0	2	**11**	5	**5**	1	0	0
Vaccinium uliginosum			5	**8**			**15**	2		0	**5**	**14**	**9**	**3**	**2**	0
Betula nana			**39**	12	2		**10**	5	2		**8**	**31**	**15**	**2**	**5**	0
Calamagrostis canadensis	1	0		1	**40**	**19**	0	**10**	**27**	**14**	2	4	0		3	
Alnus crispa			1	0			0	**27**	1	2	4	5	4	**2**	2	
Cornus canadensis	3	1		1			3	**3**	1		0					
Rosa acicularis	*2*	*0*		*1*		*0*	*1*	**2**	***19***	*5*	*1*					
Betula papyrifera		**3**		0	1	0	**1**		**58**	**39**	1	2	0			
Salix planifolia			1		2		1	**34**	2	0	0	12	0	1		0
Picea mariana	10	5	2	**23**			2	0		**24**	**32**	**6**	**4**	**5**	**2**	0
Ledum groenlandicum	1	3	0	2			**7**	1	1	2	**23**	10	2			
Pleurozium schreberi							1		**1**	0	17	3	7	0		0
Salix arbusculoides				0		1	1				0	1	0		1	
Equisetum sylvaticum						0		0	**21**	4	3	1	1		0	
Lycopodium clavatum		1					0				0		0	3	0	
Carex bigelowii			1	1							1	4	2	5		
Petasites frigidus				0						0	1	1	0		**0**	
Rubus chamaemorus											**6**	**4**	**6**	**31**	2	
Ledum decumbens			6	0			5				4	7	**10**	**4**	3	0
Empetrum nigrum			2	3						0	2	2	**5**	**8**	2	0
Eriophorum vaginatum			0				1				7	9	**56**	**6**	2	1
Oxycoccus microcarpus											0	0	**2**	**6**	0	0
Sphagnum spp.					1						15	10	**23**	**79**	**10**	4
Andromeda polifolia												0	1	**2**		0
Drosera rotundifolia											0	0	1	0		0
Aulacomnium turgidum				1							2	0	1	2	0	
Chamaedaphne calyculata					1						0	1	1	2	0	0
Tofieldia pusilla														**1**	0	
Eriophorum angustifolium						2						3			**62**	14
Carex aquatilis						2						1			**12**	**26**
Carex rostrata					0							0				**24**
Carex canescens													0			**4**
Equisetum fluviatile															0	**3**
Hippuris vulgaris																**0**
sample size	2	4	11	6	4	6	5	5	3	8	19	12	12	4	3	5

Table 6 *(cont'd)*. Mean cover (%) of the most abundant species within ecotypes on Fort Greely. (Blanks when absent, 0=<0.5%, bold signifies >60% frequency within ecotype.)

	Riverine Gravelly Barrens	*Riverine Gravelly Low and Tall Scrub*	*Riverine Gravelly Dry Dwarf Scrub*	*Riverine Gravelly Dry Meadow*	*Riverine Gravelly Dry Broadleaf Forest*	*Riverine Moist Broadleaf Forest*	*Riverine Moist Mixed Forest*	*Riverine Moist Needleleaf Forest*	*Riverine Gravelly Needleleaf Forest*
				d. Riverine.					
Astragalus eucosmus	0								
Senecio pseudo-Arnica	1								
Potentilla multifida	2	3			1				
Poa glauca	1	1							1
Agropyron pauciflorum	2		0		1				
Salix alaxensis	0	1	0					0	
Ceratodon purpureus	0	3	1		1				
Salix interior	0				0				
Elaeagnus commutata	1	**7**		0			0		1
Agropyron sp.	0			8					
Agropyron subsecundum				10	1				
Solidago decumbens	1		**0**	1	0				
Solidago canadensis									1
Taraxacum sp.		0		1					
Stellaria monantha		0		0					
Stereocaulon sp.		11	0	2	0	3			0
Dryas drummondii	0	1	**55**	1	8	15			
Oxytropis campestris	0	2	**2**	**5**	3				
Oxytropis sp.						2			
Arctostaphylos uva-ursi		0	3		4				
Populus tremuloides						30	4	1	
Shepherdia canadensis	0		**0**		**4**	2	1	3	9
Fragaria virginiana			**1**	**4**	**8**	1	8		
Populus balsamifera	0	8	**9**	3	**43**	**39**	14		1
Astragalus sp.		3		1		4	0		1
Elymus innovatus		0			11		3	1	
Aster sibiricus		0		0			0		0
Calamagrostis canadensis	0	7		3			5	17	1
Potentilla fruticosa		0			10	2	1	0	0
Picea glauca		1	**0**	0	**4**	3	**21**	**44**	**46**
Hylocomium splendens		5		1			**12**	**29**	**51**
Geocaulon lividum			0			3	**1**	1	**3**
Alnus tenuifolia			0				16		
Linnaea borealis		2				4	1	3	
Rosa acicularis					1	1	**7**	**5**	
Betula papyrifera							**19**	**3**	
Ledum groenlandicum		1				2	3	19	0
Vaccinium vitis-idaea		3					3	2	1
Viburnum edule							2	0	
sample size	4	6	3	4	4	4	8	5	4

tremuloides, Shepherdia canadensis, Vaccinium vitis-idaea, *Arctostaphylos uva-ursi*, *Polytrichum* spp., and *Cladina* spp. Loamy sites with low and tall scrub presented a problem class, with a mixture of soil properties and vegetation structures that was difficult to classify and map. Loamy moist forested sites were dominated by *Betula papyrifera*, *P. tremuloides, Picea glauca, Picea mariana, Alnus crispa, Rosa acicularis, Calamagrostis canadensis,* and *Hylocomium splendens.* In the late-successional forested ecotypes, *P. glauca, Geocaulon lividum, Linnaea borealis, H. splendens* were more important. Upland wet loamy sites were a special type restricted to north-facing slopes where permafrost reduces drainage. The Upland Wet Needleleaf Forest was similar to Lowland Wet Needleleaf Forest with a prevalence of *P. mariana, A. crispa, Ledum groenlandicum, V. vitis-idaea, H. splendens*, and *Sphagnum* spp., but had little *Betula nana* and lacked *Rubus chamaemorus.*

Lowland areas included a large number of classes whose floristics fell into broad groups associated with dry gravelly, moist loamy, and wet, organic-rich soil types (Table 6c). Ecotypes on gravelly lowlands occurred along a successional sequence from scrub to needleleaf forests and generally include *Picea glauca, Populus tremuloides*, *Populus balsamifera, Shepherdia canadensis, Arctostaphylos uva-ursi, Linnaea borealis*, and *Hylocomium splendens*. Ecotypes with somewhat well-drained to imperfectly drained loamy soils typically supported a successional sequence after fire that included *Betula papyrifera, Picea mariana, P. glauca, Alnus crispa, Rosa acicularis, Salix bebbiana, Calamagrostis canadensis*, and *Equisetum sylvaticum*. Ecotypes on wetter, bog soils generally supported various combinations that included *P. mariana, Betula nana, Vaccinium uliginosum, V. vitis-idaea, Ledum groenlandicum, L. decumbens, Empetrum nigrum, Eriophorum vaginatum, Rubus chamaemorus, Oxycoccus microcarpus,* and *Sphagnum* spp. Ecotypes on organic soils with minerotrophic groundwater movement supported *Eriophorum angustifolium, Carex aquatilis, B. nana, V. uliginosum*, and *Sphagnum* spp.

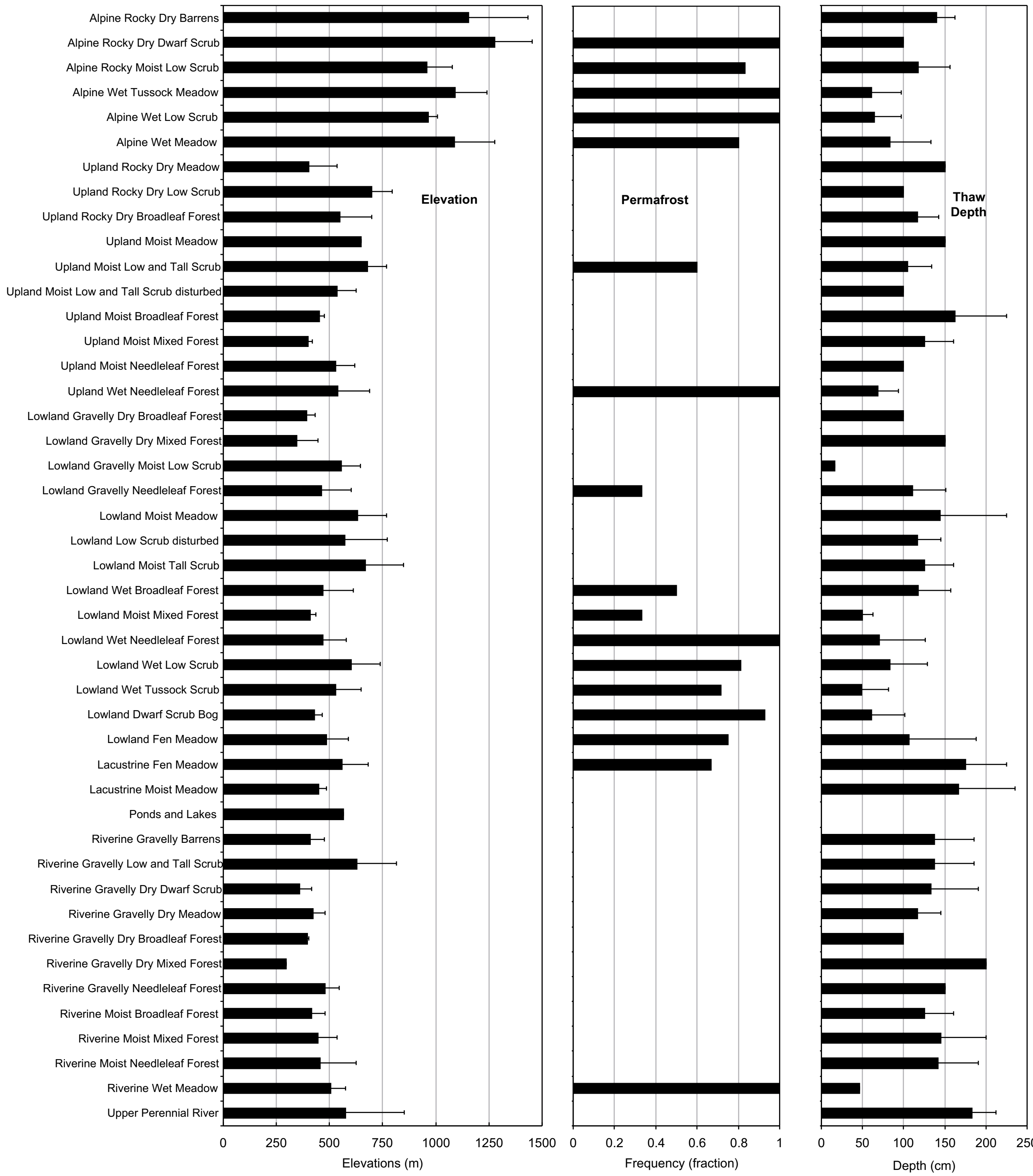
Lacustrine ecotypes included ponds with submergent vegetation, fens on organic shores, and moist loamy meadows in recently drained areas. The ponds had a unique set of aquatic species dominated by *Potamogeton* spp., *Nuphar polysepalum,* and *Isoëtes muricata.* The shorelines had emergent species such as *Carex aquatilis, C. rostrata, C. canescens, Eriophorum angustifolium, Equisetum fluviatile*, and *Hippuris vulgaris,* while moist well-drained areas were dominated by *Calamagrostis canadensis*.

Riverine ecotypes fell into two broad groups associated with gravelly and loamy soils, although distributions were somewhat variable owing to the complex nature and depositional environments associated with alluvial materials (Table 6d). Dry gravelly sites frequently included *Oxytropis campestris, Dryas drummondii, Potentilla multifida, Shepherdia canadensis, Elaeagnus commutata*, *Potentilla fruticosa, Fragaria virginiana*, *Populus balsamifera*, and *Stereocaulon* spp. In contrast, moist loamy sites frequently included *Betula papyrifera, P. balsamifera*, *Picea glauca, Alnus tenuifolia, Rosa acicularis, Geocaulon lividum, Linnaea borealis*, *Ledum groenlandicum,* and *Hylocomium splendens.*

Overall, the combination of physiography, soil texture (derived from geomorphic units), and vegetation structure appears to work well at differentiating species composition. There are numerous ways to classify vegetation and each has its own advantages and disadvantages. Vegetation structure is commonly used because it can be readily identified by remote sensing and photo interpretation. Unfortunately, structure alone is poor at differentiating species associations. Floristic analysis arguably provides the best approach to developing species associations that are closely linked to environmental properties. Floristic classes are not amenable to remote sensing, however, because only the dominant species in the canopy are visible. In addition, mapping or classification cannot be done until the analyses are completed, and results often change when new data are acquired. The ecotype approach used here has advantages from both systems, it relies on structure and landscape characteristics that can be photointerpreted, it separates classes with differing species assemblages, and classification can be done with little or no ground information. The main problem with this approach is that some distinctions are particularly equivocal. Consistent differentiation of physiography, for example, can be a problem. While differentiation of some physiographic types is relatively straight-forward, the distinction between upland and lowland areas can be confusing. While the distinction is easy in steep, hilly areas with bedrock control, the differences can be indistinct when slope changes are subtle or frequent, such as in morainal areas.

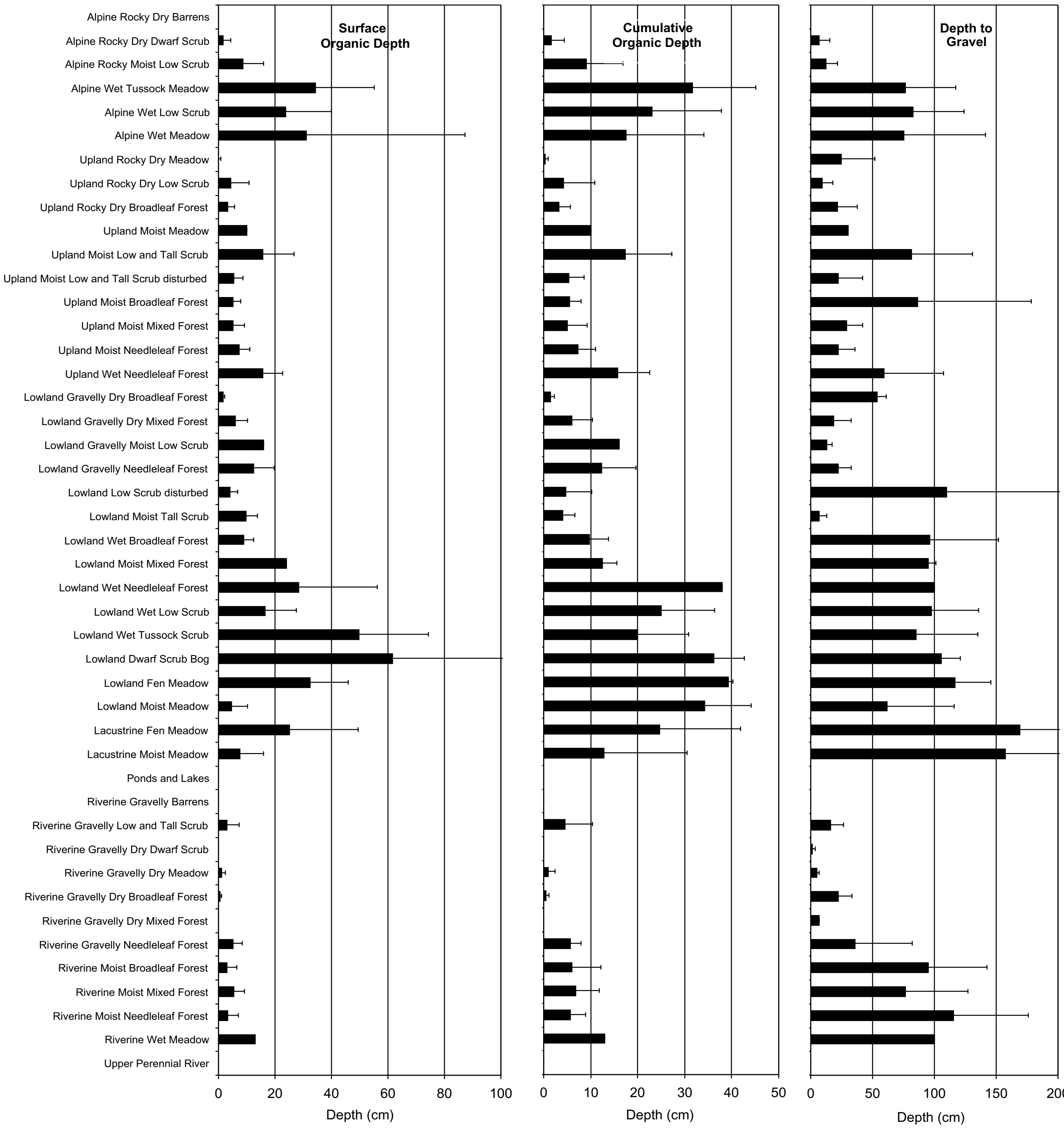
Environmental properties. A comparison of environmental properties among ecotypes reveals large differences in elevation, soil texture, permafrost occurrence, thaw depth, water depth, pH, and electrical conductivity (Fig. 11). Ecotypes were grouped by physiography to facilitate comparisons.

Elevations of the ground-reference plots ranged from 293 to 1535 m. The alpine ecotypes usually were above 900 m, with Alpine Rocky Dry Barrens and Alpine Rocky Dry Dwarf Scrub usually occurring above 1100 m (Fig.



a. Mean (±SD) elevations, frequency of occurrence of permafrost, and mean thaw depths.

Figure 11. Environmental properties for ecotypes on Fort Greely.



b. Mean (±SD) depths of surface organic matter accumulation, of cumulative organic matter accumulation in the top 40 cm, and to gravel.

Figure 11 *(cont'd)*.

c. Mean (±SD) pH, electrical conductivity (EC), and water depth (negative when below ground).

Figure 11 *(cont'd)*. Environmental properties for ecotypes on Fort Greely.

11a). Mean elevations of upland, lowland, and riverine ecotypes, while distinctly lower than alpine ecotypes, were highly variable, ranging from 300 to 700 m.

Permafrost usually was present in the alpine and loamy lowland ecotypes, whereas upland and riverine ecotypes rarely had permafrost (Fig. 11a). Two exceptions included Upland Wet Needleleaf Forest, which occurs on north-facing slopes, and Riverine Wet Meadow, which generally occurs adjacent to small headwater streams in loamy lowland areas.

Thaw depths were difficult to measure consistently in many areas because of the presence of rocky soils (Fig. 11a). Thus, thaw depths greater than 100 cm generally indicate a lack of permafrost and often were estimated by rounding up to the nearest 50 cm when permafrost was not positively identified. Thaw depths are reliable where permafrost was present. Thaw depths were least in Alpine Wet Tussock Meadow, Alpine Wet Low Scrub, Lowland Wet Tussock Scrub, Lowland Dwarf Scrub Bog, and Lowland Moist Mixed Forest. Shallow thaw depths generally were associated with wet loamy soils with thick organic accumulations.

Surface organic matter depth (uninterrupted O horizons at the surface) is a general indicator of how geomorphically stable an area is. Depths were greatest in loamy alpine and organic lowland ecotypes (Fig. 11b). Surface organic matter accumulation essentially was absent in steep Alpine Rocky Dry Barrens and Upland Rocky Dry Meadow, and in gravelly riverine ecotypes affected by scouring and sedimentation.

Cumulative organic matter depths (sum of O horizons within the top 40 cm) are a good indicator of overall decomposition rates and avoid the problems associated with irregular sediment deposition. The greatest depths were in organic and loamy lowlands, and loamy alpine ecotypes (Fig. 11b). In contrast, depths were relatively shallow for upland, gravelly lowland, and gravelly riverine ecotypes.

Depth to gravel is important for assessing the accumulation of eolian and fluvial fine-grained material and for evaluating drainage and soil moisture. Depths to gravel were the least for alpine rocky, upland rocky, lowland gravelly, and riverine gravelly ecotypes (Fig. 11b). Depths to gravel were greatest for loamy and organic lowlands. Depth to rocks or gravel was a criterion used for differentiating ecotypes, so it is no surprise that the depths are consistent with the classification. Depths greater than 50 cm, however, should be considered minimum values because depth to gravel was not always determined independently of the soil-sampling pit.

Water depths (positive when above ground, negative when below ground) were nearest the ground surface for the wet ecotypes in alpine, and loamy and organic lowland areas (Fig. 11c). Water depths in the Lowland Moist Mixed Forest, Lowland Wet Needleleaf Forest, Lowland Wet Low Scrub, and Upland Wet Needleleaf Forest often ranged below –50 cm, indicating that wetland status for these types sometimes can be uncertain. Depths greater than –50 cm, however, should be considered minimum values because it was not always possible to determine depth to water when water depths extended below the sampling pit.

Site pH (usually free soil water but occasionally soil paste) was highest for gravelly floodplains and lowest for Alpine Rocky Dry Dwarf Scrub, Lowland Wet Low Scrub, Lowland Dwarf Scrub Bog, and Upland Moist Low and Tall Scrub (Fig. 11c). Overall, most sites were slightly (6.1–6.5) to moderately (5.6–6.0) acidic.

Electrical conductivity (EC), overall, was relatively low with no saline areas evident (Fig. 11c). The highest EC values were for rivers, Riverine Gravelly Barrens, and Riverine Gravelly Dry Dwarf Scrub, Lowland Wet Broadleaf Forests, Lowland Moist Mixed Forests, and Alpine Rocky Dry Barrens. For the overwhelming majority of ecotypes, EC values were less than 100 µS/cm.

Ecosystem dynamics

Ecosystems not only have a spatial component, as described above, but also change over time in response to disturbance and succession. We identified the principal factors affecting the dynamics of ecosystems within the study area to be fluvial processes associated with channel migration and flooding, fires associated with lightning strikes and military training, thermokarst in ice-rich permafrost, and human disturbances. In the following discussion, we identify the ecotypes associated with the various disturbances and discuss the general conceptual models that have been developed to describe ecosystem dynamics.

Fluvial processes. Channel migration associated with glacial rivers is a prominent feature of the landscape on Fort Greely, but the relative proportion of affected areas in the overall landscape was relatively small. Within the study area, the area covered by water in upper perennial rivers was 3.1%, and riverine barrens covered 1.9% of the area. Early (scrub types, 1.2% of area), mid- (broadleaf and mixed forests, 2% of the area), and late- (needleleaf forests, 2.6%) successional ecotypes that have developed after disturbances occupied 5.8% of the total landscape.

Previous studies have found a characteristic pattern of vegetation succession along riverbanks in interior Alaska (Drury 1956, Viereck 1970, Viereck et al. 1993), although the gravelly floodplains on the glacial outwash are somewhat different from the ecosystems that have

been studied on silty floodplains on the lower Tanana and Yukon Rivers. Generally, these conceptual models of floodplain succession are as follows:

- Plant colonization is started by willows (0–5 years for establishment) after sufficient sediments accumulate along the active channels.
- Initial colonizers proceed through a willow–alder stage (5–10 years).
- Forest stands develop through overstory dominance by balsam poplar (20–100 years).
- Mixed stands with poplar and white spruce (100–200 years) then develop.
- Mature white spruce (200–300 years) replaces those stands.
- Black spruce (>500 years) eventually becomes dominant (Viereck et al. 1993).

The principal factors affecting this successional development are decreasing sedimentation and water-table levels, owing to increasing bank height; accumulating organics from litter and later feathermosses; burial of organic layers by flooding, which provides the characteristic soil sequence of interbedded organics; and the development of permafrost as soils become insulated by the thick organic layer (Van Cleve et al. 1993). Viereck et al. (1993) concluded that life-history characteristics and flooding events are more important during the early stages of sucession, whereas biological controls such as organic matter accumulation and competition become more important in middle and late stages.

While these simplified models explain most of the variation that we observed, ecosystem development on the floodplains is more complex than the simplified models indicate. Collins (1990) quantified changes in erosional and depositional environments between 1938 and 1982 and found the braided portion of the Tanana River near Fairbanks to be highly dynamic. Mason and Beget (1991) used stratigraphic analysis to evaluate long-term changes in depositional environment and found the following:

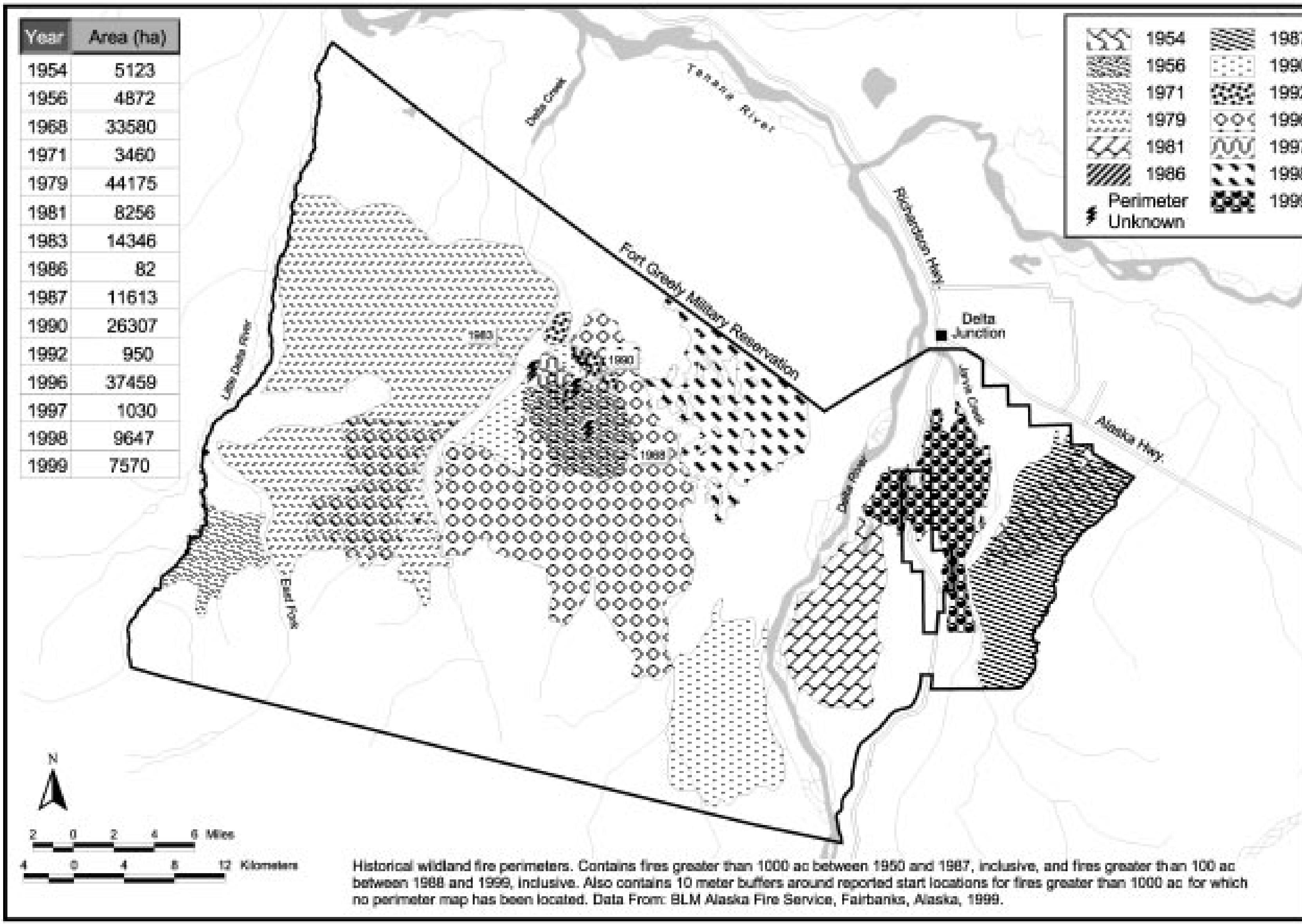
- Much of the floodplain sediments were deposited between 3000–2000 years BP.
- Deposition was much less after 2000 years BP.
- Sand units deposited during the last few hundred years point to a recent period of larger flooding events.

Mann et al. (1995) contributed to our understanding of the successional development of this complex fluvial landscape by providing a more detailed analysis of geomorphic processes, chronological development of fluvial sediments, and changes in plant macrofossils as indicators of paleoecosystems. Their analyses reveal that later stages of development are less straightforward than the Drury model suggests and that fire can be an important factor. In our analysis, the ecotypes often differed from the predicted successional sequence; for example, we observed initial colonization by *Dryas drummondii* and *Elaeagnus commutata* followed directly by *Populus balsamifera* saplings. We lacked a tall scrub stage, presumably because of the lack of sedimentation of fine-grained cover deposits during overbank flooding.

Fire. Fire is a frequent and widespread disturbance in interior Alaska that causes well-documented stages of vegetation succession (Lutz 1956, Viereck 1973, Van Cleve et al. 1983). In our study area, a compilation of forest fires through remote sensing by the Alaska Fire Service revealed that 59% (153,812 ha) of the study area has burned since 1950, although a substantial portion of this area has burned more than once (Fig. 12). The abundance of early successional ecotypes related to fire (Upland Moist Low and Tall Scrub, Upland Moist Low and Tall Scrub–disturbed, Upland Rocky Dry Low Scrub, Lowland Low Scrub–disturbed, Lowland Moist Tall Scrub, Lowland Gravelly Moist Low Scrub) tells us that approximately 16% of the entire study area has been burned recently (within approximately 30 years). Mid-successional ecotypes (broadleaf and mixed forest types) occupy approximately 5% of the area. Late successional types (upland and lowland needleleaf forests) occupy approximately 19% of the area. Two types, Lowland Tussock Scrub Bog and Lowland Wet Low Scrub, which occupied 35% of the area, have little tree cover and their composition does not appear to change substantially after fire. Overall, more of the area is covered by early successional stages or lowland tussock scrub bog than by late successional stages.

The effects of fire on ecosystem development depend on the nature of the ecosystem (i.e., species, life-history characteristics, soils), and the severity and frequency of the fire (Viereck 1973, Van Cleve et al. 1983). The severity of the fire will affect how much of the organic matter on the forest floor is burned and subsequent regeneration pathways. In general, forest stands are replaced by the same tree species (Viereck 1973, Van Cleve et al. 1983). On moist upland sites (white spruce sites), Foote (1983) identified six distinct successional stages:

- Newly burned stage during 0–3 years.
- Herb–tree stage, when fast growing mosses, herbs, and tree seedlings become established after 3–10 years.
- Tall shrub–sapling stage occurring 3–30 years after fire.



Year	Area (ha)
1954	5123
1956	4872
1968	33580
1971	3460
1979	44175
1981	8256
1983	14346
1986	82
1987	11613
1990	26307
1992	950
1996	37459
1997	1030
1998	9647
1999	7570

Figure 12. Fire occurrences on Fort Greely, 1950–1999.

- Dense tree stage of mostly birch, aspen, but also some white spruce after 15–30 years.
- Mature hardwood stage, with quaking aspen and paper birch after 50–150 years.
- Spruce stage after 100–200 years.

The successional sequence on black spruce sites is similar in structure but varies some in species composition, and includes:

- Newly burned stage, with resprouting ericaceous shrubs during 0–1 year.
- Moss–herb stage, when fast growing mosses, herbs, and tree seedling become established after 1–5 years.
- Tall shrub-sapling stage, occurring 5–30 years after fire.
- Dense tree stage of mostly birch, aspen, and black spruce after 30–55 years.
- Mixed hardwood-spruce stage, with black spruce, paper birch, and quaking aspen after 55–90 years.
- Spruce stage with black spruce and *Sphagnum* mosses after 90–200+ years.

Fire frequencies as high as every 30–55 years have been reported for some forest types in interior Alaska (Yarie 1981). Between 1940 and 1970, nearly 1% of interior Alaska forestland burned annually (Barney 1971), whereas since 1970, 0.6% of forested land has burned annually (Viereck and Schandelmeier 1980). Based on fires recorded on Fort Greely since 1950, 1.2% of the area has burned annually.

Thermokarst. While a relatively large portion of the landscape has permafrost, surface forms indicate that only a relatively small proportion of the area (notably thaw ponds) has been affected by permafrost degradation. A map of active layer depths, an indicator of permafrost presence, reveals that permafrost distribution is highly patchy, particularly in morainal areas with abrupt changes in slope and aspect (Fig. 13). In the study area, the ecotypes that generally have developed in response to thermokarst include Lacustrine Fen Meadow (1.6% of plots, although most patches were associated with kettle lakes), Lowland Fen Meadow (0.8% of plots, although some plots were associated with swales), and thaw ponds (0.1% of area). Overall, we estimate that less than 1% of the study area has undergone some degree of permafrost degradation.

Successional relationships related to permafrost degradation are poorly understood. Drury (1956) first described thermokarst processes in the upper Kuskokwim River region and the changes in vegetation associated with them, but little attention has been paid to this disturbance regime. Racine and Walters (1994) described fens on the Tanana Flats and related them to permafrost degradation and groundwater discharge from the Alaska Range. Permafrost underneath degrading birch forests, found adjacent to collapse scar fens, has been found to be extremely ice-rich, in contrast to permafrost under black spruce forests, which tends to be ice-poor (Walters et al. 1998). While permafrost degradation on the Tanana Flats has been found to be widespread (50% of frozen or previously frozen areas are in some stage of permafrost degradation) and rapid (Racine et al. 1998), little permafrost degradation has occurred on Fort Greely, presumably because of the cooler climate associated with the higher elevations and the prevalence of thaw-stable, gravelly soils.

Humans. Human disturbances include cut-and-fill associated with the construction of roads and pads, land clearing, excavation for impoundments, trail development, munitions testing and training, and contaminants. Of these disturbances, only roads, pads, clearings, and excavations were large or distinct enough to be mapped. Of the entire study area, 0.6% was Human Modified. Although little is known about the response of subarctic ecosystems to disturbance because most research in Alaska has focused on tundra ecosystems (Van Cleve 1977, Walker et al. 1987, Slaughter et al. 1989), we provide brief descriptions of types of human disturbances and references to pertinent literature below.

The effects of roads on forest ecosystems have been assessed briefly by Brown and Berg (1980), but major studies on ecological effects are lacking. In addition to the direct effects, the indirect impact of dust also has significant ecological effects (Walker and Everett 1987).

Trails resulting from training exercises and recreational activities are common, but little is known about the ecological changes and recovery potential for boreal ecosystems (Sparrow et al. 1978, Racine and Ahlstrand 1991). In addition, generalization of the ecological effects and recovery potential is made more difficult by the complex interactions of ecosystem characteristics, seasonality of impacts, number of passes, type of vehicle or foot traffic, and soil and permafrost conditions.

A wide range of contaminants has been found on Fort Wainwright (Kennedy et al. 1997) and we assume that many of these also are present to some extent on Fort Greely. Most of the contaminants probably are located in the main cantonment area and include pesticides, dioxin/furans, heavy metals, petroleum products, and other organic compounds. Most of this contamination normally is associated with leakage at buildings, tank farms, landfills, fire-training pits, drum burial sites, and coal storage. Little is known, however, about the nature and extent of contamination associated with ex-

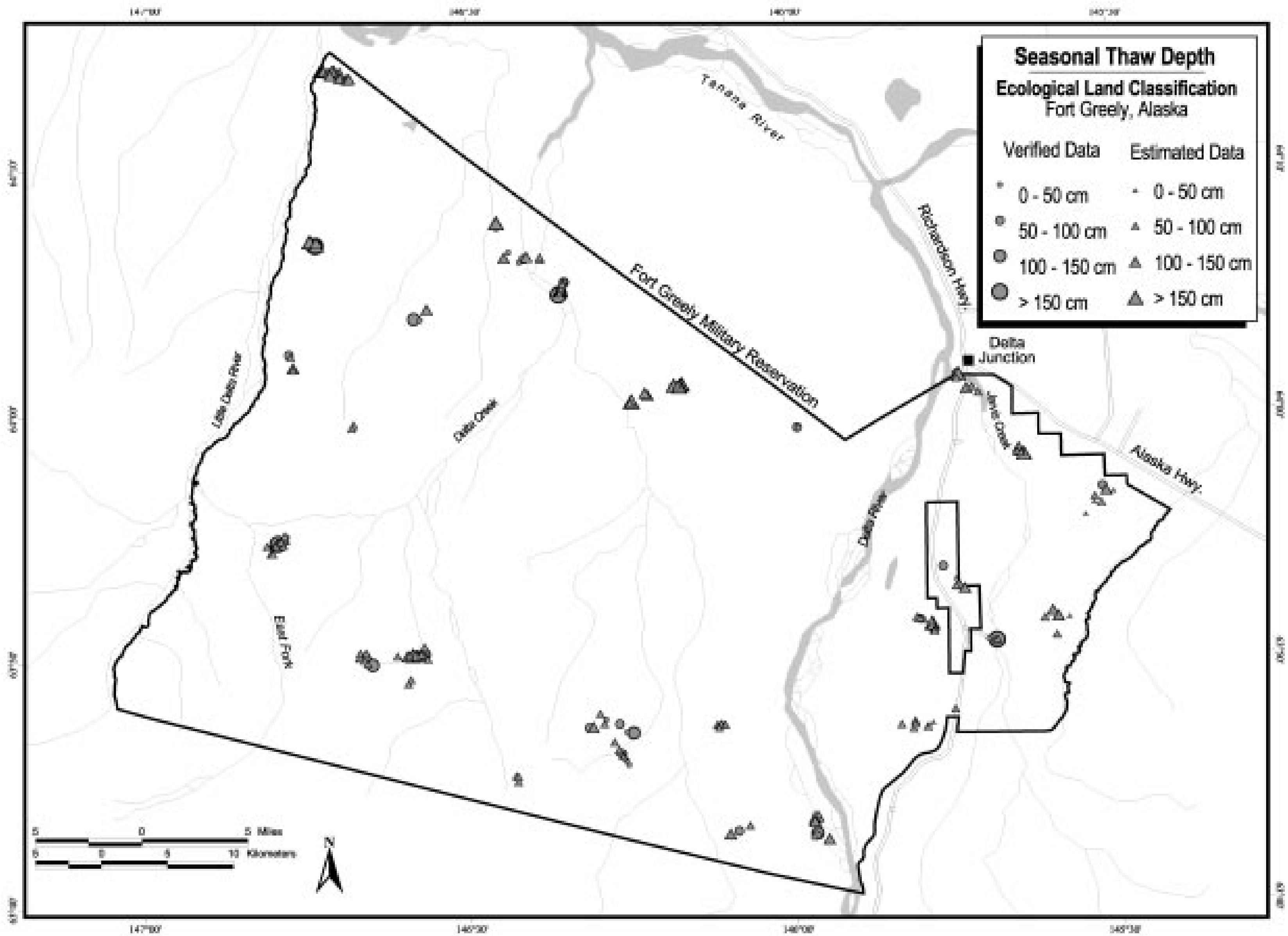


Figure 13. Active layer depths and permafrost occurrence at ground-reference plots on Fort Greely.

plosives used in the impact areas. Contaminated areas were not mapped by our study and the ecological effects of contaminants are poorly understood.

In summary, fires have had the largest overall effects (59% of area over 50 years) based on mapping of fire occurrences. Channel migration was the second most important cause of disturbance (11% over approximately 200–300 years, the general age of mature white spruce) when compared over the entire area. Human impacts have been negligible (less than 1% over approximately 50 years), although the effects of munitions impact areas and trails have not been adequately quantified and some fires are caused by human activity. Similarly, the effects of thermokarst have been negligible (less than 1% of area over approximately 200–300 years).

Ecosections

Classification and mapping

Ecosections were differentiated on the basis of geomorphic units described from field surveys and features large enough or sufficiently distinct to map. Field surveys described stratigraphy for 35 classes (Table A2). During mapping, some classes were added and some field classes were combined, resulting in 32 delineated types (Fig. 14). A combination of classes identified in field surveys and basic mapping units revealed 38 terrestrial and 6 aquatic geomorphic units important on Fort Greely (Table 7). Most of the geomorphic units were fluvial (22), eolian (3), glacial (4), or organic (5) classes. Classification and mapping were based on the geomorphic unit at the surface, although stratigraphic units commonly associated with surface geomorphic units are included in descriptions.

The dominant geomorphic units were lowland loess, hilly retransported deposits, old and young moraines, and glaciofluvial outwash, indicating the dominance of glacial and eolian processes (Table 8). Moraine deposits from the Delta (correlated with Illinoian glaciation) and Donnelly (correlated with Wisconsin glaciation) glaciations and recent and old glaciofluvial outwash cover most of the area. These glacial and glaciofluvial deposits generally are gravelly in texture, excessively to well drained, and dry.

Many of these areas were capped with wind-blown loess. A map of depth to gravel, which provides a general indication of loess thickness, reveals that older moraines and glaciofluvial outwash, particularly in areas west of the Delta River, have moderately thick (0.5–1.0 m) loess deposits (Fig. 15). The map also reveals, however, that the distribution can be very patchy, indicating differences in deposition and erosion even at locations in proximity. Most of the loess is derived from the floodplain of the Delta River, and most of the deposition is on the west side within 20 km of the river. Deposits immediately adjacent to the Delta River are as much as 14 m thick (Péwé and Holmes 1964).

Organic matter accumulation at the surface greatly alters soil properties. Unfortunately, we were not able to map organic (less than 40 cm thick) deposits separately because organic thickness was highly variable and organic terrain could not be differentiated reliably. A map of the thickness of the surface organic horizon indicates that depths were highly variable, even within small areas (Fig. 16). Areas that had a higher prevalence of organic deposits included highland moraine areas, presumably because of poor drainage and low temperatures, and hilly retransported deposits, presumably because of poor drainage in swales and lack of eolian or fluvial sedimentation. In contrast, areas lacking organic accumulation included rugged mountains, floodplains, and upland portions of lowland moraines.

Although bedrock geology was not used in differentiating ecosystems, differences in lithology can be important in assessing the stability of the surface materials and the chemistry of the soils. The dominant bedrock types in the study area, as mapped by Wilson et al. (1998), include granitic rocks, pelitic and quartoze schist, Nenana gravel, and coal-bearing rocks (Fig. 17).

Ecological relationships

Ecosections, as differentiated by geomorphic units, are ecologically relevant because they represent areas with differing erosional and depositional environments, and, therefore, are affected differentially by natural occurring disturbances. For example, Glaciofluvial Outwash Active-riverbed Deposits are subject to frequent deposition and scouring, which prevent establishment of more than a few pioneer plant species. Glaciofluvial Outwash Abandoned-riverbed Deposits lack flooding and sedimentation and, thus, tend to have gravelly, dry soils suitable for xeromorphic species. In contrast, low-lying areas with substantial loess deposits have fine-grained soils that are susceptible to the formation of ice-rich permafrost because of the thermal properties of silt. The importance of geomorphic processes on surface forms and ecological characteristics has been observed in other regions as well (Jorgenson 1984, Swanson et al. 1988, Montgomery 1997).

Water body types also differentiate numerous characteristics that are ecologically important to invertebrates, fish, and wildlife. Rivers are fundamentally different from lakes. Glacial rivers have lower water temperatures, higher suspended sediment loads, and higher mid-summer discharge than nonglacial rivers. Shallow water tends to melt earlier and become warmer than deep water. Connected lakes allow better fish passage than isolated lakes. Riverine ponds are prone to flood-

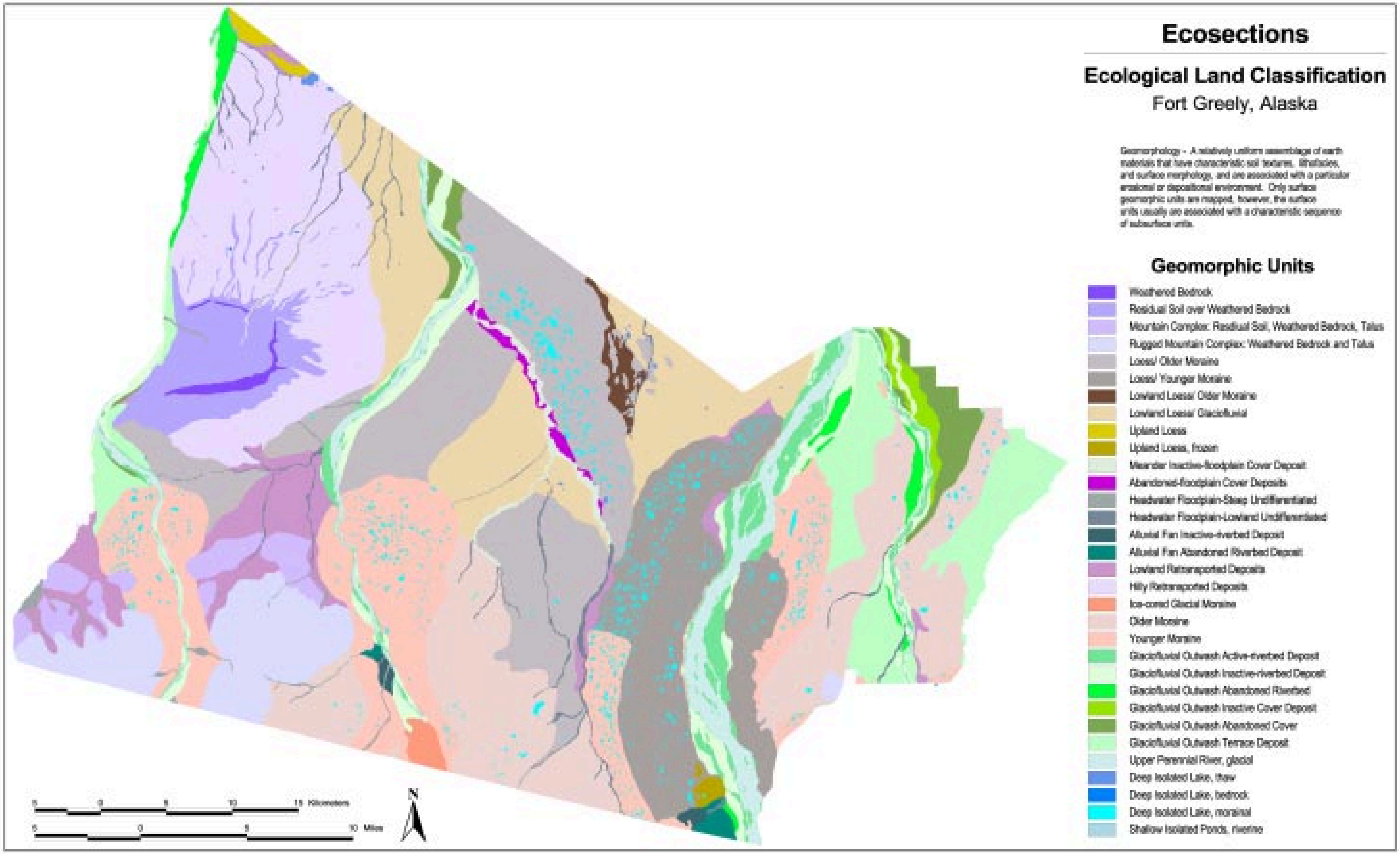


Figure 14. Ecosections based on geomorphic units for Fort Greely.

Table 7. Classification and description of geomorphic units used for differentiating ecosections within Fort Greely.

Geomorphic unit	*Description*
Weathered Bedrock (Bxw)	Highly fractured or poorly consolidated bedrock that can have soil-like properties, but has more evidence of primary structures than residual soil. Ground surface has abundance of exposed rock blocks. In the study area, this unit is limited to alpine areas where soil formation is minimal.
Residual Soil over Weathered Bedrock (Bxr)	Completely weathered material formed from underlying bedrock that has soil-like properties and little or no original primary structure remaining. Typically, particle size increases as it grades into angular weathered bedrock below. Thin (<40 cm) deposits of colluvial, eolian, or slopewash deposits may be present. Permafrost generally is absent on south facing slopes, present on north-facing slopes.
Solifluction Deposits (Cs)	Saturated soil material and rock fragments formed by downslope, viscous flow of the active layer. The unit is identified by the distinct lobate surface mounds.
Talus (Ct)	Angular rubble or rock fragments that have accumulated by gravity at the base of cliffs and steep slopes.
Lowland Loess (Ell)	Windblown silt deposited on poorly drained lowland locations in complex depositional environments near large river floodplains. The deposit may contain a mixture of eolian sand, retransported, and organic deposits in close association with the deposits of massive silt. The soil is normally frozen with a high ice content and small collapse-scar bogs are common.
Upland Loess (Elu)	Windblown silt deposited on well-drained upland slopes. Gully pattern associated with these easily eroded deposits is usually present. Massive silt deposits lack horizontal stratification and coarse fragments. Deposit must be at least 40 cm thick. Permafrost is absent.
Frozen Upland Loess (Elux)	Similar to upland loess except that it is frozen. Areas on north-facing slopes and at high elevations are more susceptible to permafrost formation.
Meander Floodplain Riverbed (Fmr)	Meandering channels that wind freely in regular to irregular, well-developed, S-shaped curves. Channels range from highly sinuous to only slightly meandering. Riverbed material can range from gravel to gravelly sand and lateral accretion deposits along point bars typically are sandier. Permafrost is absent.
Meander Active-floodplain Cover Deposit (Fmca)	Low portions of the overbank environment in proximity to the river channel that are subject to frequent flooding. Sediments typically are composed of silts and fine sands and have a laminar, interbedded structure formed by changes in velocity and deposition during waxing and waning floods. Frequent deposition prevents organic matter accumulation. Fine-grained material must be >40 cm thick and organic layers compose less than 10% of the thickness. Permafrost is absent.
Meander Inactive-floodplain Cover Deposit (Fmci)	Higher portions of the overbank environment in proximity to the river channel that are subject to infrequent flooding (approx. every 5–25 years). Sediments typically are composed of interbedded organic material, silts, and fine sands. Cover material is >40 cm thick and organic layers compose10–90% of the thickness. Permafrost is absent.
Abandoned-floodplain Cover Deposit (Fpac)	Vertical accretion deposits of a floodplain that no longer is associated with the present fluvial regime or where flooding is sufficiently infrequent that fluvial sediments form a negligible component of surface material. Surface materials include a mixture of fluvial, eolian, and organic materials but typically are highly organic. The deposit is >40 cm thick and organic layers compose >90% of the top 40 cm. Organic deposits (>40 cm) are difficult to distinguish from this unit, so this unit often includes thick accumulations of peat at the surface. Permafrost usually is present.
Headwater Floodplain, Steep Undifferentiated (Fhsu)	Small, shallow deposits formed in the upland headwaters of small creeks. Associated with steep (>4%) stream gradients, entrenched channels, and step-pool bed morphology. Due to high energy and debris transport, deposits range from boulders in narrow, incised channels to fine-grained material in broader floodplains. Channel and overbank deposits are not differentiated. Permafrost is absent.
Headwater Floodplain, Lowland Undiff. (Fhlu)	Small, shallow deposits formed in the headwaters of small creeks in lowland areas. The moderate to low stream gradients (<4%) are associated with “bog” streams and places where small streams originating from upland areas cross low-lying flat areas. Deposits usually range from gravelly sand to fine-grained and organic-rich silt. Permafrost usually is absent.
Headwater Floodplain, Steep Riverbed (Fhsr)	Small, shallow deposits formed in the riverbeds of steep headwater streams in upland areas. Deposits typically have abundant boulders and cobbles and are often constrained by bedrock.

Table 7 *(cont'd)*.

Geomorphic unit	*Description*
Headwater Floodplain, Steep Active-floodplain Cover Deposit (Fhsca)	Small, shallow deposits formed in the low overbank environment in proximity to the channels of steep headwater streams in upland areas. Sediments typically are composed of silts and fine sands and have a laminar, interbedded structure. Frequent deposition prevents organic matter accumulation. Fine-grained material must be >40 cm thick and organic layers are less than 10% of the thickness. Permafrost is absent.
Headwater Floodplain, Steep Inactive-floodplain Cover Deposit (Fhsci)	Small, shallow deposits formed in higher overbank environments in proximity to the channels of steep headwater streams in upland areas. Sediments typically are composed of interbedded organic material, silts, and fine sands. Cover material is >40 cm thick and organic layers occupy 10–90% of the thickness. Permafrost is absent.
Headwater Stream, Steep Abandoned Floodplain (Fhscb)	Small, shallow deposits formed in distal overbank environments associated with the channels of steep headwater streams in upland areas where flooding is rare. Surface materials include a mixture of fluvial and organic materials, but typically are highly organic. The deposit is >40 cm thick and organic layers compose >90% of the top 40 cm. Permafrost usually is present.
Alluvial Fan Inactive-riverbed Deposit (Ffri)	Similar to above but flooding and deposition are infrequent. Deposits include organic matter at the surface and vegetation is present. Permafrost usually is absent.
Alluvial Fan Abandoned Riverbed (Ffrb)	Similar to above, except flooding is rare. Thus, gravelly deposits have thick (>20 cm) organic layers at the surface or well developed A horizons, indicating a long period since last depositional event. Permafrost usually is absent.
Lowland Retransported Deposits (Fsl)	Fine-grained, organic-rich materials moved downslope by slopewash, solifluction, and in some cases, piping and, thus, influenced by both fluvial and gravity processes. Loess also may be incorporated in these deposits. The surface has a dendritic, feathery pattern indicative of small-scale fluvial processes. The material generally is frozen and ice rich. This unit usually occurs on the toe slopes in upland areas.
Hilly Retransported Deposits (Fsu)	Areas with gentle hill and swale topography in lowland areas. Deposits generally include silty to sandy material with occasional gravel-sized fragments that occur in horizontally stratified deposits indicative of fluvial origin. The topography may have resulted from ice aggradation and thermokarst processes or from underlying highly eroded unconsolidated material.
Glaciofluvial Deposit (GF)	Undifferentiated deposits that have been transported by glacial meltwater streams that flow within or beyond the terminal margin of an ice-sheet or glacier. Class is used to characterize subsurface deposits.
Glaciovluvial Outwash Active-riverbed Deposit	Sediments that have been deposited by glacial meltwater streams beyond the terminal glacial margin. The proglacial drift includes outwash fans, deltas, aprons, valley trains, and both pitted and nonpitted outwash plains. Sediments are composed of moderately to well-sorted, clean-washed bedload sand and gravel with some boulders. Outwash leads to an active glacial front. Braided processes and deposition are so active that vegetation is absent on interfluve bars. Permafrost is absent.
Glaciofluvial Outwash Inactive-riverbed Deposit	Similar to above, except that deposits occur adjacent to active channel where flooding and sedimentation are infrequent. Vegetation is present and thin layers (<20 cm) of organic matter have accumulated at the surface. Permafrost is absent.
Glaciofluvial Outwash Aband. Riverbed (GForb)	Deposits formed by meltwater streams beyond the terminal glacial margin. They lack significant accumulations of fine-grained cover deposits but have thick layers (>20 cm) of organic matter at the surface or have well developed A horizons in the coarse-grained soils. Permafrost is absent.
Glaciofluvial Outwash, Inactive Cov. Dep. (GFoci)	Fine-grained material deposited by overbank flooding events on glaciofluvial outwash deposits. Sediments range from sandy silts to clay material deposited in slackwater environments. Cover material is >40 cm thick and organic layers compose 10–90% of the thickness. Permafrost is absent.
Glaciofluvial Outwash Abandoned Cover (GFocb)	Fine-grained material deposited by overbank flooding events on glaciofluvial outwash deposits. Sediments range from sandy silts to clay material deposited in slackwater environments. Surface materials also have incorporated substantial amounts of wind-blown silt and organic matter. Permafrost usually is present. Groundwater seeps and linear headwater streams form a dense fluvial pattern on the surface.

Table 7 *(cont'd)*. Classification and description of geomorphic units used for differentiating ecosections within Fort Greely.

Geomorphic unit	*Description*
Glaciofluvial Outwash Terrace Deposit (Gfot)	Old deposits formed by meltwater streams beyond the terminal glacial margin that are no longer affected by the current fluvial regime. Sediments are composed of moderately to well-sorted, clean-washed bedload sand and gravel with some boulders. A thin layer (<40 cm) of wind-blown silt is often present at the surface. Due to the lack of a loamy mantle, permafrost usually is absent.
Moraine, Ice-cored (Gmi)	Residual accumulations of glacial till and remnant ice deposited by ablation at the lateral and terminal margins of modern active glaciers. The moraines are highly unstable, with steep slopes and abundant collapse features. Substantial portions are unvegetated. Moraines usually are frozen and ice-rich.
Moraine, Young (Gmy)	Relatively young moraines with steeper knob and basin topography with a poorly integrated drainage network. The deposits are composed of glacial till material deposited at the terminal or lateral margins of a glacier that has since retreated or disappeared. Younger moraines have less basin filling. Sediments are highly variable ranging from poorly sorted sand and subangular gravel with some boulders to sorted coarser subrounded material. Permafrost distribution is very patchy.
Moarine, Old (Gmo)	Similar to above except older moraines have subdued topography with broader knobs and swales and more integrated drainage network. Soils show more leaching and horizon development, permafrost is patchy.
Lacustrine (L)	Silt and clay materials deposited in both glacial and non-glacial lakes. Lake sediments generally are well stratified into very thin laminations, but may also include coarse-grained sediments associated with shorelines and fluvial sediments in deltas and fans.
Human Made Deposits	All deposits or surface modifications resulting from human activity, including fills and embankments, cuts and excavations, and accumulations of mine tailings.
Drainage Fen (Ofd)	Minerotrophic peatland forms (also called channel fens) that have a generally flat and featureless surface that slopes gently in the direction of drainage. The fens are confined to narrow, well-defined drainages in gently rolling topography. The underlying peat deposit is poorly to moderately well decomposed and ranges in thickness from 40 cm to 2 m.
Shore Fen/ Lacustrine (Ofs)	A fen with an anchored surface mat that forms the shore of a pond or lake. The rooting zone is affected by lake water. The thick (>40 cm) organic deposit is dominated by fibric sedge peat.
Basin Bog	Ombrotrophic bogs with thick (>40 cm) organic matter accumulations developed in basins with essentially closed drainage receiving their water from precipitation and immediate surroundings. The surface is flat and the water table is near the surface. Organic matter is dominated by fibric peat of *Sphagnum* mosses and ericaceous woody material but may be underlain by sedge peat.
Collapse Scar Bog	A circular or oval-shaped wet depression formed from thermal degradation of ice-rich permafrost. The depression is poor in nutrients, water input is from precipitation. This unit is associated with head-waters and abandoned floodplain cover deposits, peat is fibric derived mostly from *Sphagnum* mosses. These features were not mapped because of their small size and low abundance.
Veneer Bog (Obf)	Extensive peat deposits (>40 cm thick) that occur more or less uniformly over gently sloping hills and valleys. The bog surface is virtually unaffected by the groundwater from the surrounding mineral soils and thus is acidic and low in nutrients. Water is near the surface. The dominant materials are weakly to moderately decomposed *Sphagnum* and woody peat, sometimes underlain by sedge peat.
Upper Perennial River, Non-glacial	Permanently flooded channels of freshwater rivers where the gradient is relatively high and discharge and water quality are not affected by glacial meltwater. Water sources are not differentiated and can include surface runoff, deep groundwater, and black water from bogs. Rivers generally experience peak flooding during spring breakup and late summer and lowest water levels during mid-summer.

Table 7 *(cont'd)*.

Geomorphic unit	*Description*
Upper Perennial River, Glacial	Permanently flooded channels of freshwater rivers where the gradient is relatively high, and discharge and water quality are affected by glacial meltwater. Rivers appear brown from high concentrations of suspended sediments during mid-summer. Rivers experience peak flooding during mid-summer.
Deep Isolated Lakes, Bedrock	Deep (>1.5 m) ponds and lakes that do not freeze to the bottom during winter. These lakes are found in uplands and highlands, do not have distinct outlets and are not connected to rivers. Bottoms are rocky.
Deep Isolated Lakes, Morainal	Deep (>1.5 m) "kettle" ponds and lakes that do not freeze to the bottom during winter. The lakes do not have distinct outlets and are not connected to rivers. The lakes develop from the melting of glacial ice in moraines and typically have rocky bottoms.
Deep Isolated Lakes, Thaw	Deep (>1.5 m) ponds and lakes that do not freeze to the bottom during winter. The lakes do not have distinct outlets and are not connected to rivers. The thaw lakes develop from the melting of ice-rich permafrost and typically have muddy, organic-rich bottoms.
Shallow Isolated Pond, Riverine	Shallow (<1.5 m) ponds or small lakes associated with old river channels. Water freezes to the bottom during winter and thaws by early to mid-June. Sediments are fine-grained silt and clay.

ing and sedimentation. Only a few of these characteristics were differentiated in the final ecotypes (see *Ecotype* section) to reduce the number of classes. These waterbody types are preserved in the ecosection (geomorphic unit) codes in the map database and can be used for specific analyses, such as habitat use.

Ecodistricts

Classification and mapping

Five ecodistricts and 25 ecosubdistricts were delineated within Fort Greely, based on differences in physiography and geomorphology (Table 9, Fig. 18 and 19). Ecosubdistricts differ from ecodistricts in that ecosubdistricts delineate smaller areas with less variation in the composition of the geomorphic units.

The two main ecological factors used in differentiating ecodistricts and ecosubdistricts were physiography and climate associated with topography (topoclimate). The main factors determined by physiography were elevations and ruggedness, as exemplified by the shaded-relief map of the area (Fig. 20). Mountains and highland plateaus extended above the treeline at about 900 m. Highland areas typically ranged from 600–900 m and generally had glacial deposits or residual soils formed from bedrock. Lowland areas typically were below 600 m and generally had old glaciofluvial deposits, old moraines, retransported deposits, and lowland loess. Glaciated highlands and lowlands were differentiated because of the rugged kame and kettle topography formed by melting out of glacial ice.

Very few climate data are available for evaluating the climatic differences across the major topoclimatic boundaries used in differentiating the ecodistricts. Short-term monitoring at numerous locations by Holmes and Benninghoff (1957) found that the mean monthly air temperature for July 1955 was 13°C in the Jarvis Creek Lowlands as compared to 10°C in the Jarvis Creek Glaciated Highlands.

Ecological relationships

The ecodistricts provide a way of stratifying the distribution of ecotypes that frequently are contextually related on the landscape (Fig. 21 and 22). For example, rocky alpine ecotypes are found primarily in the Hayes and Gakona Mountain ecodistricts because of the high elevations and rugged topography. Lowland Dwarf Scrub Bogs, Lacustrine Fen Meadows, and Lowland Wet Mixed Forests were some of the ecotypes found exclusively in the Delta Lowlands. Riverine ecotypes were found primarily in the Middle Tanana Floodplain, although smaller patches were associated with small headwater streams within the Delta Lowlands and nearby highlands

This successive partitioning of the landscape is useful not only for field sampling, but improves the reliability of conceptual models of ecosystem distribution developed from toposequences. In turn, the ecodistricts are useful for land management, because management concerns and objectives will be different, depending on the predominant geomorphic and vegetation characteristics of the area.

Table 8. Areal extents of geomorphic units used for differentiating ecosections found within Fort Greely.

Geomorphic Unit	Area ha	Area %
Weathered Bedrock	805	0.3
Residual Soil over Weathered Bedrock	9,553	3.7
Mountain Complex: Residual Soil, Weathered Bedrock, Talus	4,608	1.8
Rugged Mountain Complex: Weathered Bedrock and Talus	12,373	4.8
Loess/ Older Moraine	34,890	13.4
Loess/ Younger Moraine	20,899	8.0
Lowland Loess/ Older Moraine	1,907	0.7
Lowland Loess/ Glaciofluvial	23,011	8.8
Upland Loess	566	0.2
Upland Loess, frozen	433	0.2
Meander Inactive-floodplain Cover Deposit	1,305	0.5
Abandoned-floodplain Cover Deposits	777	0.3
Headwater Floodplain-Steep Undifferentiated	1,043	0.4
Headwater Floodplain-Lowland Undifferentiated	2,645	1.0
Alluvial Fan Inactive-riverbed Deposit	437	0.2
Alluvial Fan Abandoned Riverbed Deposit	635	0.2
Lowland Retransported Deposits	9,274	3.6
Hilly Retransported Deposits	27,194	10.4
Ice-cored Glacial Moraine	824	0.3
Older Moraine	30,572	11.7
Younger Moraine	29,395	11.3
Glaciofluvial Outwash Active-riverbed Deposit	6,613	2.5
Glaciofluvial Outwash Inactive-riverbed Deposit	8,005	3.1
Glaciofluvial Outwash Abandoned Riverbed	2,267	0.9
Glaciofluvial Outwash Inactive Cover Deposit	1,164	0.4
Glaciofluvial Outwash Abandoned Cover	3,861	1.5
Glaciofluvial Outwash Terrace Deposit	13,969	5.4
Deep Isolated Lake, Bedrock	9	<0.1
Deep Isolated Lake, Morainal	3,194	1.2
Deep Isolated Lake, Thaw	185	0.1
Shallow Isolated Ponds, Riverine	2	<0.1
Upper Perennial River, Glacial	7,819	3.0
Total	260,234	100

Recognition of ecosystem differences within these broad areas also helps identify gaps where more information is needed for land management. For example, considerable research has been conducted on the eastern side of the Delta River, particularly in the Delta Lowlands, where access is easy (Holmes and Benninghoff 1957, Péwé and Reger 1983). Conversely, little is known about ecological processes on the western side of the base or for other ecodistricts. Similarly, the ecological processes associated with the glacial outwash in the Middle Tanana Floodplain are substantially different from the pattern and processes that have been extensively studied on the meandering floodplain associated with the Lower Tanana Floodplain. For land management, then, more information may need to be collected on ecological processes in the other ecodistricts on Fort Greely to address specific management priorities.

SUMMARY AND CONCLUSIONS

An ecological land survey (ELS) of Fort Greely land was conducted to map ecosystems at three spatial scales to aid in the management of natural resources. In an ELS, landscapes are viewed not just as aggregations of separate biological and earth resources, but also as ecological systems with functionally related parts that can provide a consistent conceptual framework for modeling, analyzing, interpreting, and applying ecological knowledge. More explicitly, land management activities such as ecological risk assessments, analysis and mapping of terrain sensitivity, wildlife habitats, wetland distribution, planning for training exercises, identification of rare habitats, and fire management all require spatially explicit information and a method of organizing ecological information. To provide the information required for such a wide range of applica-

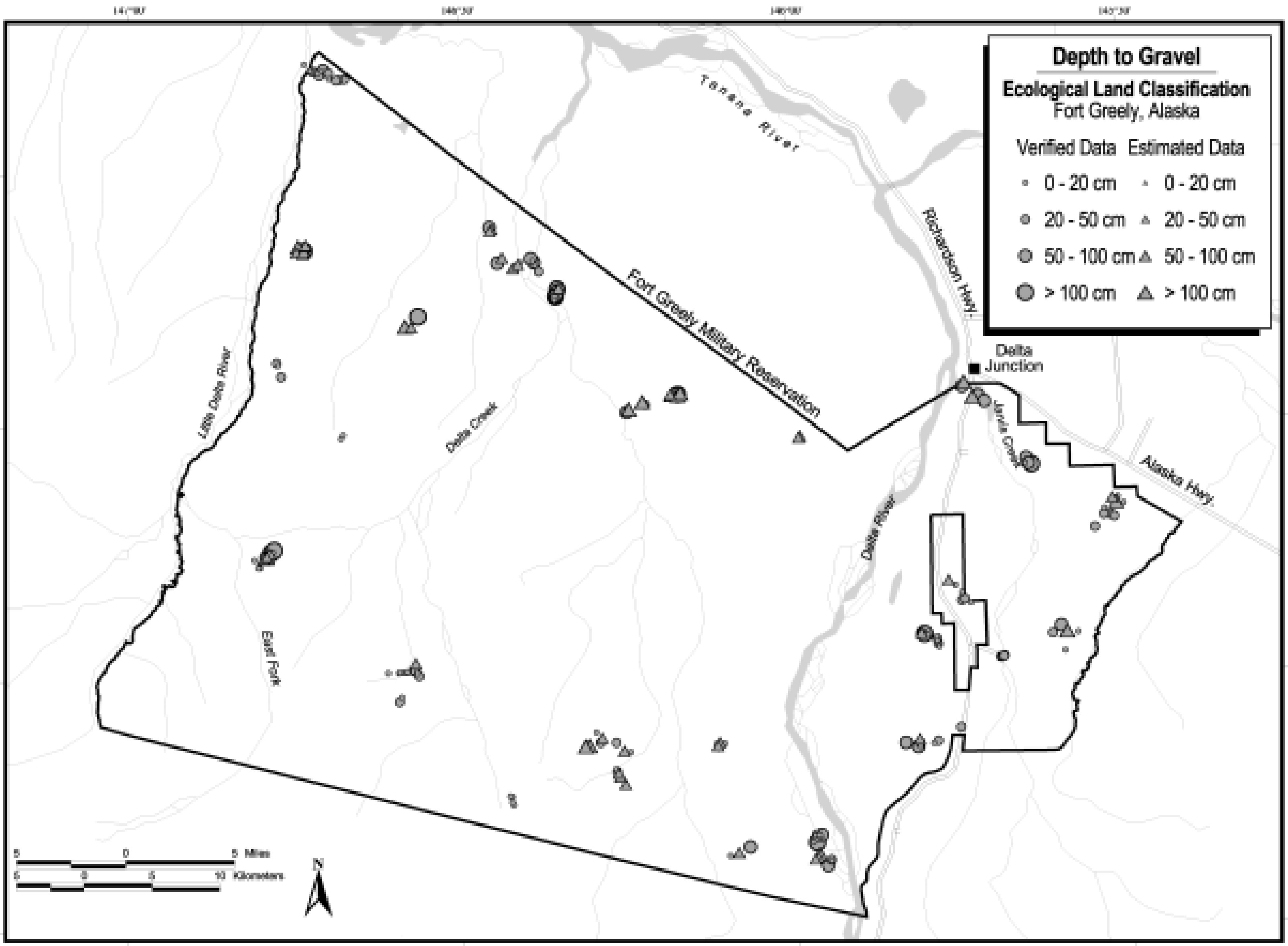


Figure 15. Depth to gravel at ground-reference plots on Fort Greely.

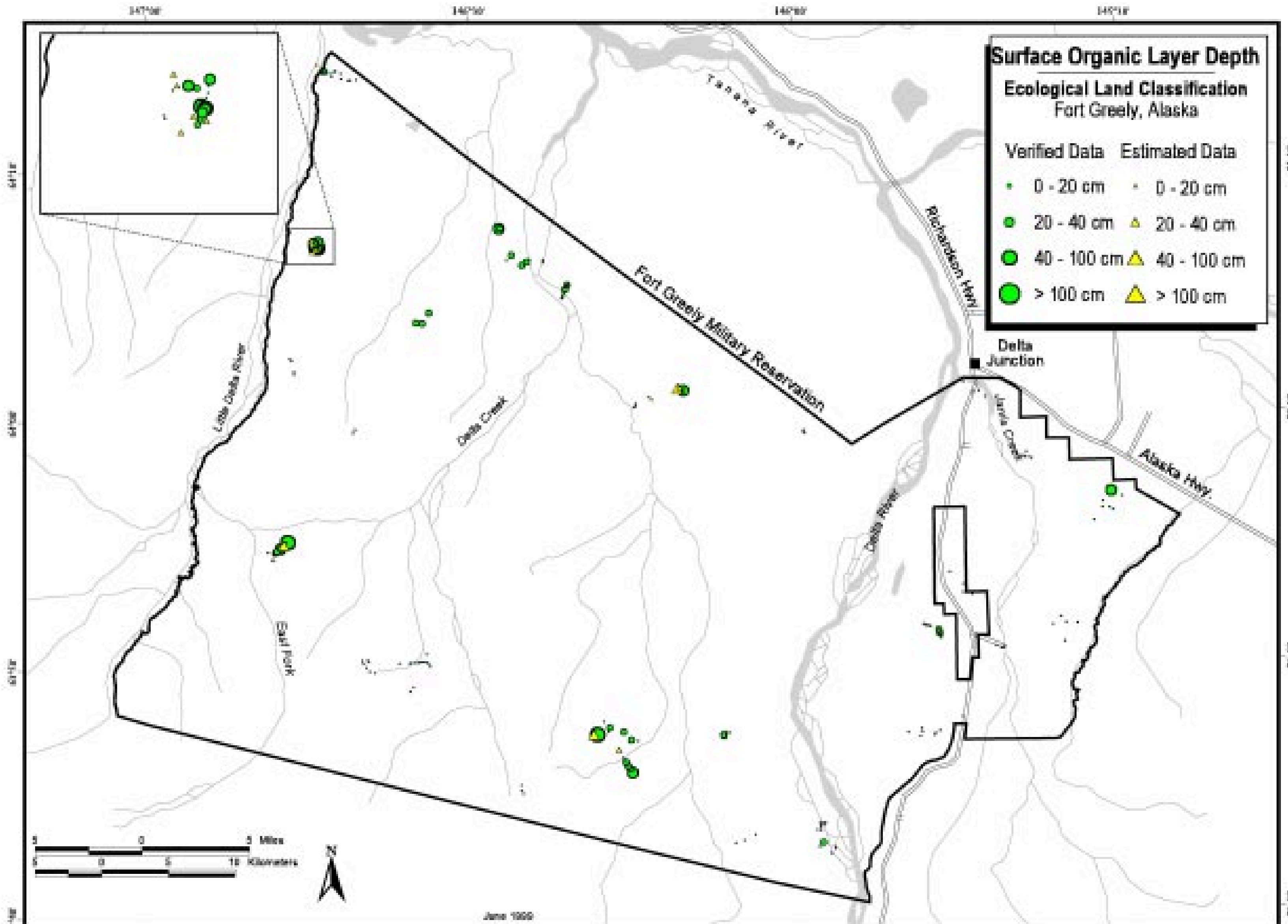


Figure 16. Depth of organics at ground-reference plots on Fort Greely.

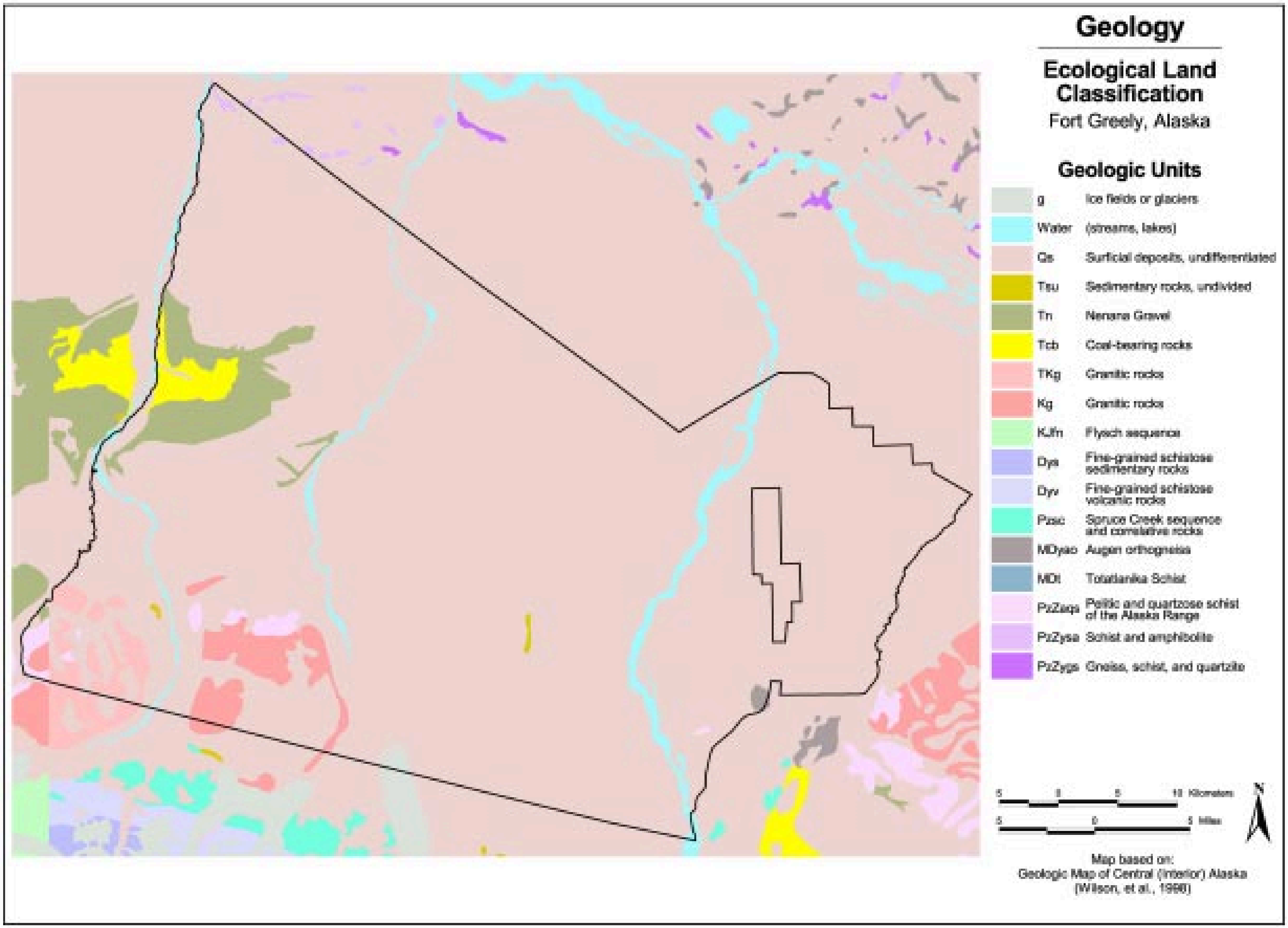


Figure 17. Geology of Fort Greely.

Table 9. Hierarchical grouping of ecodistricts and ecosubdistricts, and their areas, within Fort Greely.

*Ecoregions**	*Ecodistricts*	*Ecosubdistricts*	*Geomorphic Unit Codes†*	*Area (ha)*
Alaska Range Mountains	Hayes Mountains	Molybdenum Ridge Mountains	Bxr, Ct, Fsl	12,503
		Hayes Glaciers	Gg, Gmi	561
	Gakona Mountains	Granite Mountains (Donnelly Dome)	Bxr, Ct, Fsl	274
Interior Highlands (Northern Foothills of the Alaska Range)	Delta Highlands	Hayes Highland Plateaus	Gmo, Obv	12,802
		Donnelly Highland Plateau	Gmo, Obv	1,415
		Dinosaur Ridge Highlands	Bxr, Ct, Fsu, Fsl	22,951
		Jarvis Creek Glaciated Highlands	Gmo, Gmy, Fsl, Obv, Ofsh	2,696
		Delta River Glaciated Highlands	Gmo, Fsl, Obv, Ofsh	31,502
		Little Delta River Glaciated Highlands	Gmo, Fsl, Obv, Ofsh	8,080
		Little Delta River Highlands	Bxr, Ct, Fsl	7,463
Interior Forested Lowlands and Uplands	Delta Lowlands (Tanana Flats to Robertson River)	Jarvis Creek Glaciated Lowlands	Elu, Ell, Gmo, Obv, Ofsh	19,662
		Jarvis Creek Lowlands	Gfo, Obv	10,596
		Granite Creek Lowlands	Gfo	4,887
		Delta River Glaciated Lowlands	Elu, Ell, Gmo, Obv, Ofsh	32,016
		Delta River Lowlands	Gfo, Ell, Obv, Fmr, Fmci	21,816
		Delta Creek Glaciated Lowlands	Gmo, Fsl	9,717
		Upper Delta Creek Lowlands	Gfo, Fsl	8,537
		Lower Delta Creek Lowlands	Fsr, Fsl, Gfo, Obv	23,327
		Upper Little Delta River Lowlands	Gfo, Fsr, Obv	1,879
		Lower Little Delta River Lowlands	Gfo, Fsl	482
		Arctic Creek Uplands	Elu, Bxr, Fsl	794
Interior Bottomlands	Middle Tanana Floodplain (Fairbanks to Robertson River)	Jarvis Creek Floodplain	Gfora, Gfori, Gfoci, Gforb, Gfocb, Wrug	3,920
		Delta River Floodplain	Gfora, Gfori, Gfoci, Gforb, Wrug	12,766
		Delta Creek Floodplain	Gfora, Gfori, Gfoci, Gfocb, Wrug	6,786
		Little Delta River Floodplain	Gfora, Gfori, Gfoci, Gforb, Gfocb, Wrug	3,744

*Ecoregions from *Ecoregions of Alaska* (Gallant et al. 1995).
†Geomorphic codes follow mnemonic system, first letters are: B=Bedrock, C=Colluvial, E=Eolian, F=Fluvial, G=Glacial, O=Organic, W=Waterbody (see Table 1).

tions, an ELS requires three types of efforts:

- An ecological land survey that inventories and analyzes data obtained in the field.
- An ecological land classification that classifies and maps ecosystem distribution.
- An ecological land evaluation that assesses the capabilities of the land for various land management practices.

Field surveys at 74 sites along seven toposequences and at an additional 178 ground-reference locations were used to develop a better understanding of the ecological processes controlling landscape development in the study area. Co-varying relationships among physiography, geomorphology, hydrology, permafrost, and vegetation were identified using field survey data. The association among ecosystem components also helped identify linkages among ecosystems related to fire effects and geomorphic processes, such as groundwater discharge, floodplain development, permafrost degradation, and paludification. The association of vegetation structures (e.g., closed deciduous forests) with geomorphic units (e.g., inactive cover deposits) was used to identify 47 ecotypes (local ecosystems) that were effective at differentiating dominant species (e.g., balsam poplar in riverine moist broadleaf forest versus paper birch in upland moist broadleaf forest) and floristic associations.

Ecosystems were mapped at three spatial scales for the entire base. Ecotypes (1:50,000 scale) delineated areas with homogenous topography, terrain, soil, sur-

Ecosubdistricts of the Fort Greely Area.

Figure 18. Aerial views of ecosubdistricts within Fort Greely.

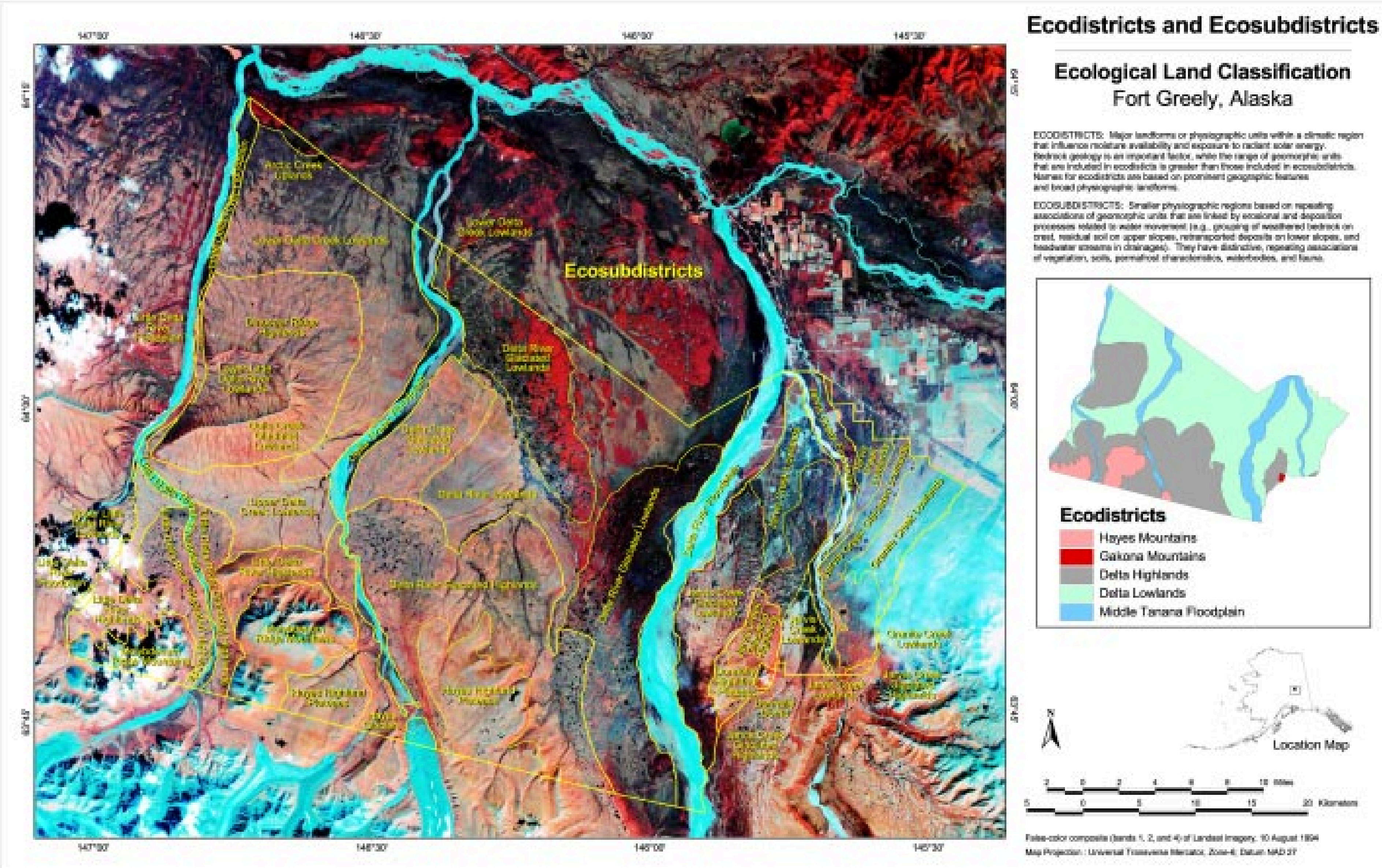


Figure 19. Ecodistricts and ecosubdistricts for Fort Greely.

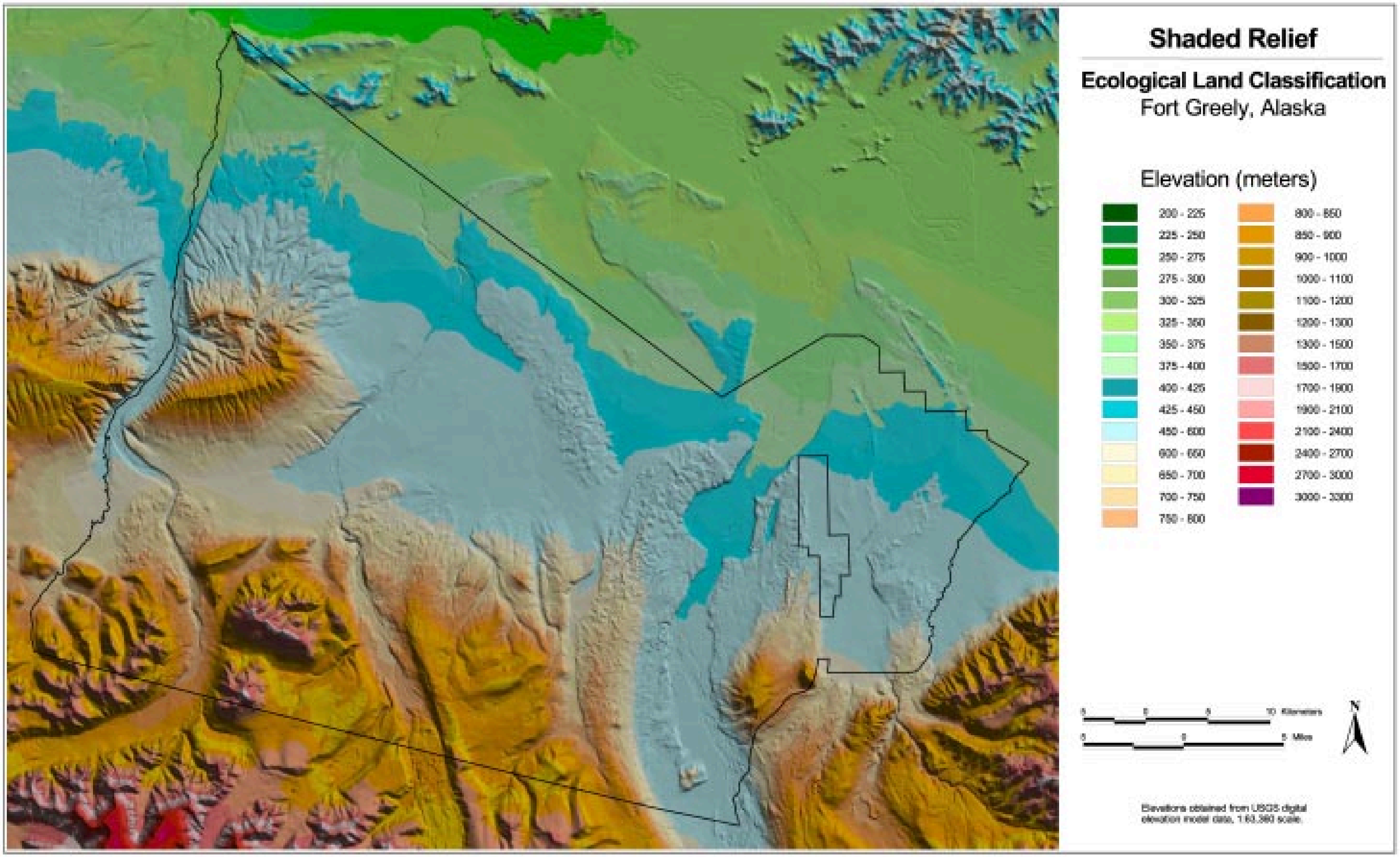


Figure 20. Shaded-relief map of Fort Greely.

ECOLOGICAL PROFILE OF GLACIATED TERRAIN IN THE DELTA LOWLANDS

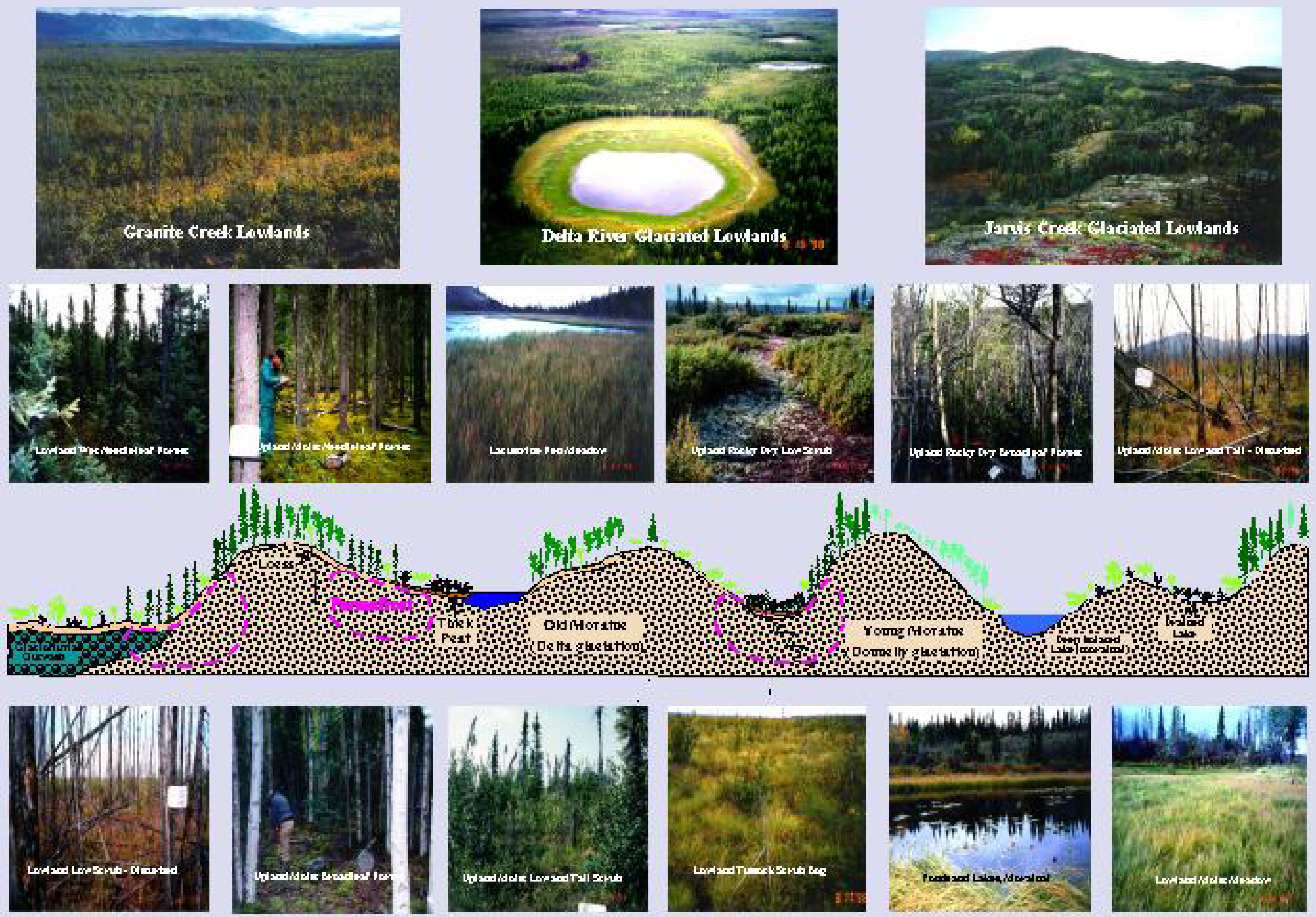


Figure 21. Generalized profile of ecological characteristics of glaciated terrain within the Delta Lowlands ecodistrict on Fort Greely.

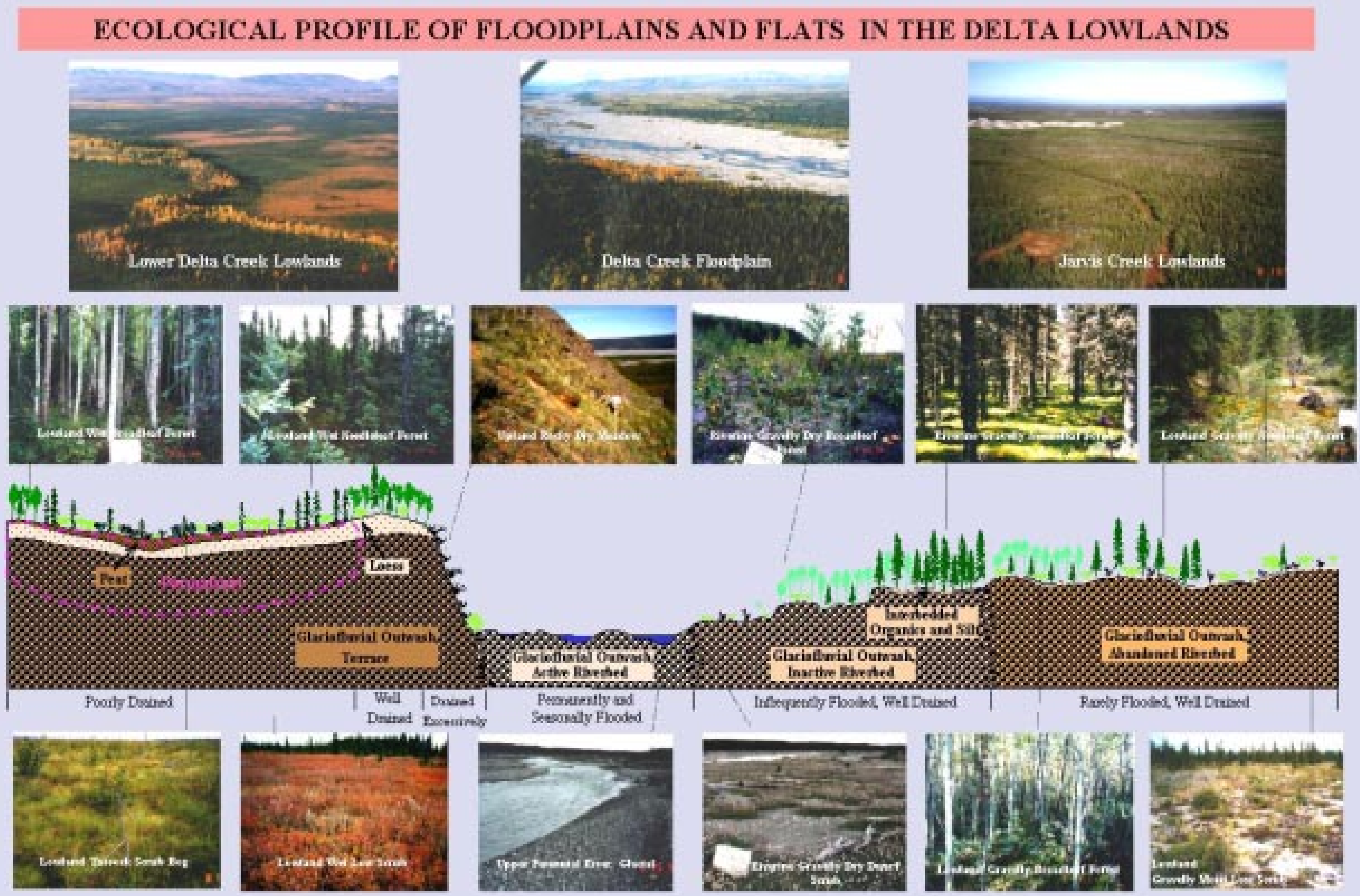


Figure 22. Generalized profile of ecological characteristics of floodplains and flats within the Delta Lowlands ecodistrict on Fort Greely.

face form, hydrology, and vegetation. Important environmental properties (elevation, permafrost occurrence, organic matter accumulation, depth to gravel, water depths, pH, and electrical conductivity) for the ecotypes were summarized from data obtained from field surveys. Ecosections (1:100,000 scale) are homogeneous with respect to geomorphic features and water regime and, thus, have recurring patterns of soils and vegetation. Although several vegetation classes can be included in an ecosection, the vegetation classes usually are related because they occur as different stages in a successional sequence. Ecodistricts (1:500,000) are broader areas with similar geology, geomorphology, and hydrology, and are more synonymous with physiographic units.

This spatial database now can become the foundation for numerous management objectives such as wetland protection, integrated training-area management, permafrost protection, wildlife management, and recreational area management. The hierarchical approach, which incorporates multiple ecosystem components into general ecotypes, allows users to partition the variability of a wide range of ecological characteristics. The ELS approach also will help managers create specialized thematic maps based on re-coding of the map database, and, thus, provides flexibility for addressing a wide range of management objectives. Finally, the database's structure allows its continued development within a geographic information system to further aid management objectives.

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Table A1. System used for aggregating geomorphic and vegetation classes into ecotypes classes, Fort Greely, central Alaska, 1999.

Ecotype code	Ecotype Group Name	Geomorphic Unit	Geomorph Name	AK Vegetation Class Code	Alaska Vegetation Class Name
30453	Riverine Wet Meadow	483	Headwater Inactive-floodplain Cover Deposit	340	Subarctic Lowland Sedge Wet Meadow
30631	Riverine Moist Needleleaf Forest	712	Glaciofluvial Outwash Inactive-cover Deposit	112	Closed White Spruce Forest
30631	Riverine Moist Needleleaf Forest	712	Glaciofluvial Outwash Inactive-cover Deposit	124	Open White Spruce Forest
30631	Riverine Moist Needleleaf Forest	447	Meander Inactive-floodplain Cover Deposit	112	Closed White Spruce Forest
30631	Riverine Moist Needleleaf Forest	447	Meander Inactive-floodplain Cover Deposit	124	Open White Spruce Forest
30631	Riverine Moist Needleleaf Forest	483	Headwater Inactive-floodplain Cover Deposit	124	Open White Spruce Forest
30632	Riverine Moist Broadleaf Forest	711	Glaciofluvial Outwash Active-cover Deposit	214	Open Balsam Poplar Dwarf Tree Scrub
30632	Riverine Moist Broadleaf Forest	712	Glaciofluvial Outwash Inactive-cover Deposit	145	Closed Quaking Aspen Forest
30632	Riverine Moist Broadleaf Forest	712	Glaciofluvial Outwash Inactive-cover Deposit	147	Closed Quaking Aspen–Balsam Poplar Forest
30632	Riverine Moist Broadleaf Forest	447	Meander Inactive-floodplain Cover Deposit	145	Closed Quaking Aspen Forest
30633	Riverine Moist Mixed Forest	712	Glaciofluvial Outwash Inactive-cover Deposit	174	Closed Quaking Aspen–Spruce Forest
30633	Riverine Moist Mixed Forest	712	Glaciofluvial Outwash Inactive-cover Deposit	175	Closed Balsam Poplar–White Spruce Forest
30633	Riverine Moist Mixed Forest	712	Glaciofluvial Outwash Inactive-cover Deposit	181	Open Spruce–Paper Birch Forest
30633	Riverine Moist Mixed Forest	712	Glaciofluvial Outwash Inactive-cover Deposit	184	Open Spruce–Balsam Poplar Forest
30633	Riverine Moist Mixed Forest	445	Meander Active-floodplain Cover Deposit	175	Closed Balsam Poplar–White Spruce Forest
30633	Riverine Moist Mixed Forest	447	Meander Inactive-floodplain Cover Deposit	173	Closed Spruce–Paper Birch–Quaking Aspen Forest
30633	Riverine Moist Mixed Forest	483	Headwater Inactive-floodplain Cover Deposit	171	Closed Spruce–Paper Birch Forest
30633	Riverine Moist Mixed Forest	483	Headwater Inactive-floodplain Cover Deposit	181	Open Spruce–Paper Birch Forest
38031	Riverine Gravelly Needleleaf Forest	712	Glaciofluvial Outwash Inactive-cover Deposit	124	Open White Spruce Forest
38040	Riverine Gravelly Low and Tall Scrub	711	Glaciofluvial Outwash Active-cover Deposit	153	Open Balsam Poplar Forest
38040	Riverine Gravelly Low and Tall Scrub	711	Glaciofluvial Outwash Active-cover Deposit	260	Open Low Willow Shrub
38040	Riverine Gravelly Low and Tall Scrub	712	Glaciofluvial Outwash Inactive-cover Deposit	266	Open Low Silverberry Shrub
38040	Riverine Gravelly Low and Tall Scrub	483	Headwater Inactive-floodplain Cover Deposit	232	Open Tall Alder Shrub
38040	Riverine Gravelly Low and Tall Scrub	506	Alluvial Fan Incactive Cover	222	Closed Tall Alder Shrub
38090	Riverine Gravelly Barrens	702	Glaciofluvial Outwash Active-riverbed deposit	0	Barren (<5% vegetated)
38090	Riverine Gravelly Barrens	711	Glaciofluvial Outwash Active-cover Deposit	351	Dry Seral Herb
38211	Upper Perennial River	481	Headwater Stream Riverbed Deposit	1	Water (<5% vegetated)
38211	Upper Perennial River	911	Upper Perennial River, non-glacial	1	Water (<5% vegetated)
38211	Upper Perennial River	912	Upper Perennial River, glacial	1	Water (<5% vegetated)
38832	Riverine Gravelly Dry Broadleaf Forest	711	Glaciofluvial Outwash Active-cover Deposit	153	Open Balsam Poplar Forest
38832	Riverine Gravelly Dry Broadleaf Forest	712	Glaciofluvial Outwash Inactive-cover Deposit	153	Open Balsam Poplar Forest
38832	Riverine Gravelly Dry Broadleaf Forest	712	Glaciofluvial Outwash Inactive-cover Deposit	165	Broadleaf–Scrub Woodland
38833	Riverine Gravelly Dry Mixed Forest	711	Glaciofluvial Outwash Active-cover Deposit	184	Open Spruce–Balsam Poplar Forest
38843	Riverine Gravelly Dry Dwarf Scrub	702	Glaciofluvial Outwash Active-riverbed deposit	271	Dryas Dwarf Shrub Tundra
38843	Riverine Gravelly Dry Dwarf Scrub	711	Glaciofluvial Outwash Active-cover Deposit	271	Dryas Dwarf Shrub Tundra
38843	Riverine Gravelly Dry Dwarf Scrub	447	Meander Inactive-floodplain Cover Deposit	162	Balsam Poplar Woodland
38851	Riverine Gravelly Dry Meadow	712	Glaciofluvial Outwash Inactive-cover Deposit	303	Dry Fescue
38851	Riverine Gravelly Dry Meadow	712	Glaciofluvial Outwash Inactive-cover Deposit	304	Midgrass–Shrub
38851	Riverine Gravelly Dry Meadow	712	Glaciofluvial Outwash Inactive-cover Deposit	305	Midgrass–Herb
40220	Ponds and Lakes	947	Shallow Isolated Ponds, morainal or kettle	381	Pondlily
40652	Lacustrine Moist Meadow	750	Lacustrine	311	Bluejoint Meadow
40652	Lacustrine Moist Meadow	750	Lacustrine	313	Bluejoint–Shrub
40652	Lacustrine Moist Meadow	750	Lacustrine	361	Mesic Mixed Herbs
40652	Lacustrine Moist Meadow	885	Shore Bog (non-floating)/ Lacustrine	313	Bluejoint–Shrub
41456	Lacustrine Fen Meadow	750	Lacustrine	340	Subarctic Lowland Sedge Wet Meadow
41456	Lacustrine Fen Meadow	854	Shore Fen/ Lacustrine	340	Subarctic Lowland Sedge Wet Meadow

Table A1 *(cont'd)*. System used for aggregating geomorphic and vegetation classes into ecotypes classes, Fort Greely, central Alaska, 1999.

Ecotype code	Ecotype Group Name	Geomorphic Unit	Geomorph Name	AK Vegetation Class Code	Alaska Vegetation Class Name
50431	Lowland Wet Needleleaf Forest	371	Lowland Loess	125	Open Black Spruce Forest
50431	Lowland Wet Needleleaf Forest	452	Abandoned-floodplain Cover Deposit	125	Open Black Spruce Forest
50431	Lowland Wet Needleleaf Forest	452	Abandoned-floodplain Cover Deposit	128	Open Black Spruce–White Spruce Forest
50431	Lowland Wet Needleleaf Forest	520	Lowland Retransported Deposits	125	Open Black Spruce Forest
50431	Lowland Wet Needleleaf Forest	520	Lowland Retransported Deposits	211	Open Black Spruce Dwarf Tree Scrub
50431	Lowland Wet Needleleaf Forest	621	Older Morraine	124	Open White Spruce Forest
50431	Lowland Wet Needleleaf Forest	715	Glaciofluvial Outwash Abandoned Cover	113	Closed Black Spruce Forest
50431	Lowland Wet Needleleaf Forest	715	Glaciofluvial Outwash Abandoned Cover	125	Open Black Spruce Forest
50431	Lowland Wet Needleleaf Forest	715	Glaciofluvial Outwash Abandoned Cover	134	Black Spruce Woodland
50431	Lowland Wet Needleleaf Forest	715	Glaciofluvial Outwash Abandoned Cover	135	Black Spruce–White Spruce Woodland
50431	Lowland Wet Needleleaf Forest	888	Veneer Bog	125	Open Black Spruce Forest
50431	Lowland Wet Needleleaf Forest	888	Veneer Bog	134	Black Spruce Woodland
50432	Lowland Wet Broadleaf Forest	452	Abandoned-floodplain Cover Deposit	144	Closed Paper Birch Forest
50432	Lowland Wet Broadleaf Forest	622	Younger Morraine	151	Open Paper Birch Forest
50432	Lowland Wet Broadleaf Forest	715	Glaciofluvial Outwash Abandoned Cover	144	Closed Paper Birch Forest
50433	Lowland Wet Mixed Forest	715	Glaciofluvial Outwash Abandoned Cover	171	Closed Spruce–Paper Birch Forest
50442	Lowland Wet Low Scrub	330	Solifluction Deposits	253	Open Low Mesic Shrub Birch–Ericaceous Shrub
50442	Lowland Wet Low Scrub	330	Solifluction Deposits	257	Open Low Shrub Birch–Willow Shrub
50442	Lowland Wet Low Scrub	371	Lowland Loess	255	Open Low Shrub Birch–Ericaceous Shrub Bog
50442	Lowland Wet Low Scrub	452	Abandoned-floodplain Cover Deposit	134	Black Spruce Woodland
50442	Lowland Wet Low Scrub	483	Headwater Inactive-floodplain Cover Deposit	246	Closed Low Shrub Birch–Ericaceous Shrub
50442	Lowland Wet Low Scrub	483	Headwater Inactive-floodplain Cover Deposit	260	Open Low Willow Shrub
50442	Lowland Wet Low Scrub	520	Lowland Retransported Deposits	191	Spruce–Paper Birch Woodland
50442	Lowland Wet Low Scrub	520	Lowland Retransported Deposits	246	Closed Low Shrub Birch–Ericaceous Shrub
50442	Lowland Wet Low Scrub	520	Lowland Retransported Deposits	255	Open Low Shrub Birch–Ericaceous Shrub Bog
50442	Lowland Wet Low Scrub	621	Older Morraine	134	Black Spruce Woodland
50442	Lowland Wet Low Scrub	621	Older Morraine	241	Closed Shrub Birch Shrub
50442	Lowland Wet Low Scrub	621	Older Morraine	257	Open Low Shrub Birch–Willow Shrub
50442	Lowland Wet Low Scrub	622	Younger Morraine	246	Closed Low Shrub Birch–Ericaceous Shrub
50442	Lowland Wet Low Scrub	622	Younger Morraine	255	Open Low Shrub Birch–Ericaceous Shrub Bog
50442	Lowland Wet Low Scrub	705	Glaciofluvial Outwash Abandoned Riverbed	253	Open Low Mesic Shrub Birch–Ericaceous Shrub
50442	Lowland Wet Low Scrub	715	Glaciofluvial Outwash Abandoned Cover	191	Spruce–Paper Birch Woodland
50442	Lowland Wet Low Scrub	888	Veneer Bog	255	Open Low Shrub Birch–Ericaceous Shrub Bog
50641	Lowland Moist Tall Scrub	621	Older Morraine	224	Closed Tall Alder–Willow Shrub
50641	Lowland Moist Tall Scrub	621	Older Morraine	232	Open Tall Alder Shrub
50641	Lowland Moist Tall Scrub	622	Younger Morraine	221	Closed Tall Willow Shrub
50641	Lowland Moist Tall Scrub	715	Glaciofluvial Outwash Abandoned Cover	231	Open Tall Willow Shrub
50652	Lowland Moist Meadow	452	Abandoned-floodplain Cover Deposit	318	Subarctic Lowland Sedge Moist Meadow
50652	Lowland Moist Meadow	622	Younger Morraine	306	Hair-grass
50652	Lowland Moist Meadow	622	Younger Morraine	311	Bluejoint Meadow
50652	Lowland Moist Meadow	622	Younger Morraine	318	Subarctic Lowland Sedge Moist Meadow
51444	Lowland Dwarf Scrub Bog	715	Glaciofluvial Outwash Abandoned Cover	216	Black Spruce Dwarf Tree Woodland
51444	Lowland Dwarf Scrub Bog	715	Glaciofluvial Outwash Abandoned Cover	256	Open Low Ericaceous Shrub Bog
51444	Lowland Dwarf Scrub Bog	888	Veneer Bog	256	Open Low Ericaceous Shrub Bog
51456	Lowland Fen Meadow	621	Older Morraine	340	Subarctic Lowland Sedge Wet Meadow
51456	Lowland Fen Meadow	843	Drainage (or Channel) Fen	340	Subarctic Lowland Sedge Wet Meadow

Table A1 *(cont'd)*.

Ecotype code	Ecotype Group Name	Geomorphic Unit	Geomorph Name	AK Vegetation Class Code	Alaska Vegetation Class Name
51456	Lowland Fen Meadow	843	Drainage (or Channel) Fen	341	Subarctic Lowland Sedge–Shrub Wet Meadow
51458	Lowland Tussock Scrub Bog	371	Lowland Loess	252	Open Low Mixed Shrub–Sedge Tussock Bog
51458	Lowland Tussock Scrub Bog	622	Younger Morraine	252	Open Low Mixed Shrub–Sedge Tussock Bog
51458	Lowland Tussock Scrub Bog	715	Glaciofluvial Outwash Abandoned Cover	252	Open Low Mixed Shrub–Sedge Tussock Bog
51458	Lowland Tussock Scrub Bog	872	Fill, gravel (should be Basin Bog)	252	Open Low Mixed Shrub–Sedge Tussock Bog
51458	Lowland Tussock Scrub Bog	888	Veneer Bog	134	Black Spruce Woodland
51458	Lowland Tussock Scrub Bog	888	Veneer Bog	252	Open Low Mixed Shrub–Sedge Tussock Bog
58031	Lowland Gravelly Needleleaf Forest	458	Abandoned-floodplain - gravel	112	Closed White Spruce Forest
58031	Lowland Gravelly Needleleaf Forest	458	Abandoned-floodplain - gravel	124	Open White Spruce Forest
58031	Lowland Gravelly Needleleaf Forest	621	Older Morraine	113	Closed Black Spruce Forest
58031	Lowland Gravelly Needleleaf Forest	705	Glaciofluvial Outwash Abandoned Riverbed	125	Open Black Spruce Forest
58031	Lowland Gravelly Needleleaf Forest	705	Glaciofluvial Outwash Abandoned Riverbed	133	White Spruce Woodland
58031	Lowland Gravelly Needleleaf Forest	715	Glaciofluvial Outwash Abandoned Cover	125	Open Black Spruce Forest
58642	Lowland Gravelly Moist Low Scrub	715	Glaciofluvial Outwash Abandoned Cover	253	Open Low Mesic Shrub Birch–Ericaceous Shrub
58832	Lowland Gravelly Dry Broadleaf Forest	374	Lowland Loess, unfrozen	147	Closed Quaking Aspen–Balsam Poplar Forest
58832	Lowland Gravelly Dry Broadleaf Forest	715	Glaciofluvial Outwash Abandoned Cover	174	Closed Quaking Aspen–Spruce Forest
58833	Lowland Gravelly Dry Mixed Forest	458	Abandoned-floodplain - gravel	176	Closed Spruce–Quaking Aspen–Balsam Poplar Forest
58833	Lowland Gravelly Dry Mixed Forest	458	Abandoned-floodplain - gravel	182	Open Quaking Aspen–Spruce Forest
58833	Lowland Gravelly Dry Mixed Forest	705	Glaciofluvial Outwash Abandoned Riverbed	182	Open Quaking Aspen–Spruce Forest
59042	Lowland Low Scrub disturbed	621	Older Morraine	259	Open Low Scrub (post burn, disturbance)
59042	Lowland Low Scrub disturbed	622	Younger Morraine	134	Black Spruce Woodland
59042	Lowland Low Scrub disturbed	622	Younger Morraine	362	Fireweed
59042	Lowland Low Scrub disturbed	705	Glaciofluvial Outwash Abandoned Riverbed	362	Fireweed
70431	Upland Wet Needleleaf Forest	373	Upland Loess, frozen	124	Open White Spruce Forest
70431	Upland Wet Needleleaf Forest	621	Older Morraine	124	Open White Spruce Forest
70431	Upland Wet Needleleaf Forest	621	Older Morraine	125	Open Black Spruce Forest
70431	Upland Wet Needleleaf Forest	622	Younger Morraine	125	Open Black Spruce Forest
70631	Upland Moist Needleleaf Forest	372	Upland Loess	112	Closed White Spruce Forest
70631	Upland Moist Needleleaf Forest	621	Older Morraine	125	Open Black Spruce Forest
70631	Upland Moist Needleleaf Forest	622	Younger Morraine	125	Open Black Spruce Forest
70632	Upland Moist Broadleaf Forest	372	Upland Loess	144	Closed Paper Birch Forest
70632	Upland Moist Broadleaf Forest	372	Upland Loess	151	Open Paper Birch Forest
70632	Upland Moist Broadleaf Forest	372	Upland Loess	152	Open Quaking Aspen Forest
70632	Upland Moist Broadleaf Forest	621	Older Morraine	144	Closed Paper Birch Forest
70633	Upland Moist Mixed Forest	372	Upland Loess	171	Closed Spruce–Paper Birch Forest
70633	Upland Moist Mixed Forest	621	Older Morraine	173	Closed Spruce–Paper Birch–Quaking Aspen Forest
70640	Upland Moist Low and Tall Scrub	12	Residual Soil over Weathered Bedrock	224	Closed Tall Alder–Willow Shrub
70640	Upland Moist Low and Tall Scrub	372	Upland Loess	133	White Spruce Woodland
70640	Upland Moist Low and Tall Scrub	373	Upland Loess, frozen	222	Closed Tall Alder Shrub
70640	Upland Moist Low and Tall Scrub	621	Older Morraine	224	Closed Tall Alder–Willow Shrub
70640	Upland Moist Low and Tall Scrub	621	Older Morraine	241	Closed Shrub Birch Shrub
70640	Upland Moist Low and Tall Scrub	621	Older Morraine	257	Open Low Shrub Birch–Willow Shrub
70640	Upland Moist Low and Tall Scrub	622	Younger Morraine	192	Spruce–Quaking Aspen Woodland
70640	Upland Moist Low and Tall Scrub	622	Younger Morraine	222	Closed Tall Alder Shrub
70640	Upland Moist Low and Tall Scrub	622	Younger Morraine	232	Open Tall Alder Shrub
70652	Upland Moist Meadow	12	Residual Soil over Weathered Bedrock	313	Bluejoint–Shrub

Table A1 *(cont'd)*. System used for aggregating geomorphic and vegetation classes into ecotypes classes, Fort Greely, central Alaska, 1999.

Ecotype code	Ecotype Group Name	Geomorphic Unit	Geomorph Name	AK Vegetation Class Code	Alaska Vegetation Class Name
78832	Upland Rocky Dry Broadleaf Forest	12	Residual Soil over Weathered Bedrock	145	Closed Quaking Aspen Forest
78832	Upland Rocky Dry Broadleaf Forest	372	Upland Loess	145	Closed Quaking Aspen Forest
78832	Upland Rocky Dry Broadleaf Forest	372	Upland Loess	213	Open Quaking Aspen Dwarf Tree Scrub
78832	Upland Rocky Dry Broadleaf Forest	621	Older Morraine	144	Closed Paper Birch Forest
78832	Upland Rocky Dry Broadleaf Forest	622	Younger Morraine	154	Open Paper Birch–Quaking Aspen Forest
78832	Upland Rocky Dry Broadleaf Forest	622	Younger Morraine	213	Open Quaking Aspen Dwarf Tree Scrub
78842	Upland Rocky Dry Low Scrub	621	Older Morraine	241	Closed Shrub Birch Shrub
78842	Upland Rocky Dry Low Scrub	621	Older Morraine	253	Open Low Mesic Shrub Birch–Ericaceous Shrub
78842	Upland Rocky Dry Low Scrub	621	Older Morraine	281	Bearberry Dwarf Shrub Tundra
78842	Upland Rocky Dry Low Scrub	622	Younger Morraine	133	White Spruce Woodland
78842	Upland Rocky Dry Low Scrub	622	Younger Morraine	191	Spruce–Paper Birch Woodland
78842	Upland Rocky Dry Low Scrub	622	Younger Morraine	213	Open Quaking Aspen Dwarf Tree Scrub
78842	Upland Rocky Dry Low Scrub	622	Younger Morraine	222	Closed Tall Alder Shrub
78842	Upland Rocky Dry Low Scrub	622	Younger Morraine	253	Open Low Mesic Shrub Birch–Ericaceous Shrub
78851	Upland Rocky Dry Meadow	11	Weathered Bedrock	268	Sagebrush–Grass
78851	Upland Rocky Dry Meadow	12	Residual Soil over Weathered Bedrock	305	Midgrass–Herb
78851	Upland Rocky Dry Meadow	372	Upland Loess	304	Midgrass–Shrub
79640	Upland Moist Low and Tall Scrub disturbed	372	Upland Loess	259	Open Low Scrub (post burn, disturbance)
79640	Upland Moist Low and Tall Scrub disturbed	621	Older Morraine	259	Open Low Scrub (post burn, disturbance)
79640	Upland Moist Low and Tall Scrub disturbed	622	Younger Morraine	362	Fireweed
110442	Alpine Wet Low Scrub	330	Solifluction Deposits	243	Closed Low Shrub Birch–Willow Shrub
110442	Alpine Wet Low Scrub	330	Solifluction Deposits	246	Closed Low Shrub Birch–Ericaceous Shrub
110442	Alpine Wet Low Scrub	335	Talus	232	Open Tall Alder Shrub
110442	Alpine Wet Low Scrub	482	Headwater Active-floodplain Cover Deposit	242	Closed Low Willow Shrub
110442	Alpine Wet Low Scrub	483	Headwater Inactive-floodplain Cover Deposit	241	Closed Shrub Birch Shrub
110442	Alpine Wet Low Scrub	621	Older Morraine	241	Closed Shrub Birch Shrub
110442	Alpine Wet Low Scrub	621	Older Morraine	257	Open Low Shrub Birch–Willow Shrub
110442	Alpine Wet Low Scrub	621	Older Morraine	322	Sedge–Birch Tundra
110442	Alpine Wet Low Scrub	874	Collapse Scar Bog/ Floodplain	262	Open Low Willow–Graminoid Shrub Bog
110442	Alpine Wet Low Scrub	888	Veneer Bog	255	Open Low Shrub Birch–Ericaceous Shrub Bog
110453	Alpine Wet Meadow	483	Headwater Inactive-floodplain Cover Deposit	331	Wet Sedge Meadow Tundra
110453	Alpine Wet Meadow	484	Headwater Abandoned-floodplain Cover Deposit	322	Sedge–Birch Tundra
110453	Alpine Wet Meadow	520	Lowland Retransported Deposits	312	Bluejoint–Herb
110453	Alpine Wet Meadow	520	Lowland Retransported Deposits	331	Wet Sedge Meadow Tundra
110453	Alpine Wet Meadow	843	Drainage (or Channel) Fen	331	Wet Sedge Meadow Tundra
110458	Alpine Wet Tussock Meadow	520	Lowland Retransported Deposits	314	Tussock Tundra
110458	Alpine Wet Tussock Meadow	621	Older Morraine	314	Tussock Tundra
110458	Alpine Wet Tussock Meadow	888	Veneer Bog	314	Tussock Tundra
118642	Alpine Rocky Moist Low Scrub	11	Weathered Bedrock	242	Closed Low Willow Shrub
118642	Alpine Rocky Moist Low Scrub	12	Residual Soil over Weathered Bedrock	245	Closed Low Alder–Willow Shrub
118642	Alpine Rocky Moist Low Scrub	12	Residual Soil over Weathered Bedrock	253	Open Low Mesic Shrub Birch–Ericaceous Shrub
118642	Alpine Rocky Moist Low Scrub	330	Solifluction Deposits	232	Open Tall Alder Shrub

Table A1 *(cont'd)*.

Ecotype code	Ecotype Group Name	Geomorphic Unit	Geomorph Name	AK Vegetation Class Code	Alaska Vegetation Class Name
118642	Alpine Rocky Moist Low Scrub	330	Solifluction Deposits	265	Open Low Alder Shrub
118642	Alpine Rocky Moist Low Scrub	335	Talus	153	Open Balsam Poplar Forest
118642	Alpine Rocky Moist Low Scrub	335	Talus	222	Closed Tall Alder Shrub
118642	Alpine Rocky Moist Low Scrub	335	Talus	232	Open Tall Alder Shrub
118642	Alpine Rocky Moist Low Scrub	335	Talus	257	Open Low Shrub Birch–Willow Shrub
118642	Alpine Rocky Moist Low Scrub	621	Older Morraine	232	Open Tall Alder Shrub
118642	Alpine Rocky Moist Low Scrub	621	Older Morraine	253	Open Low Mesic Shrub Birch–Ericaceous Shrub
118843	Alpine Rocky Dry Dwarf Scrub	11	Weathered Bedrock	271	Dryas Dwarf Shrub Tundra
118843	Alpine Rocky Dry Dwarf Scrub	11	Weathered Bedrock	272	Dryas–Sedge Dwarf Shrub Tundra
118843	Alpine Rocky Dry Dwarf Scrub	11	Weathered Bedrock	273	Dryas–Lichen Dwarf Shrub Tundra
118843	Alpine Rocky Dry Dwarf Scrub	12	Residual Soil over Weathered Bedrock	272	Dryas–Sedge Dwarf Shrub Tundra
118843	Alpine Rocky Dry Dwarf Scrub	12	Residual Soil over Weathered Bedrock	273	Dryas–Lichen Dwarf Shrub Tundra
118843	Alpine Rocky Dry Dwarf Scrub	335	Talus	285	Cassiope Dwarf Shrub Tundra
118843	Alpine Rocky Dry Dwarf Scrub	520	Lowland Retransported Deposits	280	Ericaceous Dwarf Scrub
118843	Alpine Rocky Dry Dwarf Scrub	621	Older Morraine	273	Dryas–Lichen Dwarf Shrub Tundra
118890	Alpine Rocky Dry Barrens	11	Weathered Bedrock	10	Partially Vegetated (>5,<30% cover)
118890	Alpine Rocky Dry Barrens	335	Talus	0	Barren (<5% vegetated)
118890	Alpine Rocky Dry Barrens	335	Talus	10	Partially Vegetated (>5,<30% cover)
118890	Alpine Rocky Dry Barrens	622	Younger Morraine	0	Barren (<5% vegetated)
118890	Alpine Rocky Dry Barrens	622	Younger Morraine	10	Partially Vegetated (>5,<30% cover)

APPENDIX B: GROUND REFERENCE DATA

Table B1. Data file listing environmental characteristics of ground-reference plots, Fort Greely, Alaska, 1999.

Plot name	Date	Latitude (NAD27)	Longitude (NAD27)	Elevation (m)	Physiography	Geomorph	Slope (deg)	Aspect (deg)	Surface form	Water depth (cm)	NWI-Water Regim	Sat 30 cm (Y,N,ND)	Drainage general	Hydr soil (present,absent)	Permafrost (present,absent, unknown)	Thaw depth (cm)	SurfOrgDepth (cm)	CumOrg40 (cm)	DomMinTe (0–50 cm)	GravDep (cm)	Lithosequence	pH	EC
G1.01A	07/21/96	64.118122	-146.734838	460	Lowland	888	2	45	38	- 6	Saturated	Y	P	P	A	>182	105	40	O	152	Om/Fm/Gfm	5	30
G1.01B	07/21/96	64.118122	-146.734838	460	Lowland	888	2	45	38	- 32	Upland	N	P	P	P	86	86	40	O	>86	Om		
G1.02	07/21/96	64.11652	-146.734577	465	Lowland	888	2	315	48	>-32	Saturated	Y	P	P	P	31	>31	>31	nd	>31	Om		
G1.03	07/21/96	64.120424	-146.744377	457	Floodplain	483	0.0	0.0	71	>-180	Upland	N	W	A	A	>180	0	0	S	>180	Fm/Ol		
G1.04	07/21/96	64.120948:	-146.743211	457	Lowland	843	0.0	0.0	79	- 13	Saturated	Y	P	P	P	49	>34	>34	O	>34	Om		
G1.05	07/21/96	64.122441	-146.744122	457	Lowland	888	0.0	0.0	61	>-27	Saturated	Y	P	P	P	31	>27	>27	nd	>27	Om		
G1.06	07/21/96	64.121021:	-146.739758	460	Lowland	888	0.0	0.0	31	- 9	Saturated	Y	P	P	P	42	43	40	O	>43	Om		
G1.07	07/21/96	64.120711:	-146.737184	460	Lowland	520	0.0	0.0	61	- 16	Saturated	Y	P	P	P	42	22	22	L	>42	Om/Fgm		
G1.501A	07/21/96	64.117244:	-146.746816	457	Floodplain	483	0.0	0.0	71	>-29	Saturated	Y	P	P	P	29	8	>24	L	>29	Fl/Fom		
G1.501B	07/21/96	64.116850:	-146.746559	457	Floodplain	483	0.0	0.0	70	8	Season flooded	Y	P	P	P	46	13	13	L	>46	Om/Fl		
G1.502	07/21/96	64.115065	-146.742111	460	Lowland	888	0.0	0.0	61	- 19	Saturated	Y	P	P	P	32	>32	>32	nd	>32	Om	5.2	30
G1.503	07/21/96	64.11704	-146.73845	460	Lowland	888	0.0	0.0	61	>-31	Saturated	Y	P	P	P	31	>31	>31	nd	>31	Om		
G10.01a	08/17/98	64.236831	-146.72523	297	Floodplain	702	0.0	0.0	70	>-50	Season flooded	N	E	A	A	>150	0	0	RE	0	Gfm/Gm	8.6	290
G10.01b	08/17/98	64.236616	-146.723647	297	Floodplain	711	0.0	0.0	71	>-50	Upland	N	E	A	A	>150	0	0	RE	7	Gm	7.6	40
G10.01c	08/17/98	64.240929	-146.734309	293	Floodplain	912	10	92	30		Perm flooded	Y	E	P	A	nd	0	0	RE	0	Gm	8.6	290
G10.02a	08/17/98	64.236587	-146.722271	297	Lowland	458	0.0	0.0	71	>-100	Upland	N	E	A	A	>100	23	23	RE	33	Om/Fm/Gm	6.3	90
G10.03b	08/17/98	64.23624	-146.72201	297	Lowland	458	0.0	0.0	71	>-100	Upland	N	E	A	A	>100	6	6	RE	6	Om/Gm	6.3	0.0
G10.05	08/17/98	64.235217	-146.713938	298	Lowland	458	0.0	0.0	71	>-100	Upland	N	E	A	A	>100	3	3	RE	3	Gm	6.1	10
G10.07a	08/17/98	64.235229:	-146.697033	377	Upland	372	16	204	21	>-100	Upland	N	W	A	A	>100	8	8	L	38	Om/Fm/Gfm	5.5	40
G10.07b	08/17/98	64.236758	-146.705475	343	Upland	372	24	205	21	>-100	Upland	N	E	A	A	>100	5	5	L	52	Fm/R	7.1	40
G10.10a	08/17/98	64.231576	-146.696823	349	Upland	12	29	165	6	>-100	Upland	N	E	A	A	>100	0	0	RE	13	Fgm/R	6.8	10
G10.11a	08/17/98	64.230468	-146.685495	445	Upland	372	24	215	11	>-100	Upland	N	E	A	A	>100	2	2	RE	21	Om/Fm/R	7.6	40
G10.12	08/17/98	64.2308	-146.682198	459	Upland	372	16	155	11	>-100	Upland	N	W	A	A	>100	8	8	L	37	Fm/R		
G10.14a	08/17/98	64.231088	-146.673651	426	Upland	372	18	156	11	>-100	Upland	N	W	A	U	nd	10	10	L	38	Om/Fm/R	5.6	40
G10.21	08/17/98	64.236341	-146.708583	304	Upland	11	85	200	7	>-100	Upland	N	E	A	A	>100	0	0	RE	5	Fm/Gfm	7.9	230
G10.22	08/17/98	64.233416	-146.711357	299	Lowland	458	0.0	0.0	71	>-100	Upland	N	E	A	A	>100	4	4	RE	24	Om/Sm/Gm	5.7	10
G11.01	08/27/96	64.131414	-146.451754	400	Lowland	715	0.0	0.0	71	16	Season flooded	Y	P	P	P	48	28	28	L	>48	Om/Fom	6.5	30
G11.02	08/27/96	64.130393	-146.454163	400	Lowland	843	0.0	0.0	70	+8 to -15	Season flooded	Y	P	P	P	70	42	40	L	>70	Om/Fl	20	
G11.03	08/27/96	64.130812	-146.453005	400	Lowland	715	0.0	0.0	71	- 31	Saturated	Y	nd	P	P	30	21	21	L	>29	Om/Fom	10	
G11.04	08/27/96	64.132563	-146.45461	400	Floodplain	483	0.0	0.0	71	>-31	Upland	N	W	A	A	>225	11	11	S	87	Om/Fl/Gmg		
G11.10	08/16/98	64.108972	-146.442904	397	Lowland	715	0.0	0.0	61	- 15	Saturated	Y	P	P	A	>100	8	8	L	86	O/Fm/Gm	5.5	50
G11.12a	08/16/98	64.112667	-146.43585	393	Lowland	715	0.0	0.0	70	-17	Saturated	Y	P	P	P	42	27	38	L	>42	Om/Ol	5.3	40
G11.16a	08/16/98	64.105830:	-146.419192	397	Lowland	715	0.0	0.0	70	- 10	Saturated	Y	P	P	P	50	37	39	L	>50	Om/Ol	5.5	30
G11.20	08/16/98	64.109515	-146.407619	381	Floodplain	702	0.0	0.0	70	>-40	Season flooded	n	E	A	A	>100	0	0	RE	0	Gm	10	
G11.21	08/16/98	64.108151	-146.411764	391	Lowland	715	0.0	0.0	71	- 29	Saturated	y	W	P	P	59	24	38	L	>59	Om/Ol/Fm/O	4.6	230
G12.01	08/27/96	64.043754	-146.777365	831	Upland	330	15	340	23	- 22	Saturated	Y	P	P	P	63	16	20	R	23	Om/Rfm/Fomt	5.1	36
G12.02	08/27/96	64.042348	-146.774635	762	Upland	12	25	225	21	>-34	Upland	N	E	A	A	>34	1	1	R	13	Fgm/Gfm	5.5	30
G12.03	08/27/96	64.034954	-146.77071	648	Upland	12	30	45	23	>-40	Upland	N	P	A	A	>120	10	10	R	30	Fm/Fgm/Gfm	4.8	52
G12.04	08/27/96	64.033488	-146.771026	60:	Floodplain	483	2	180	70	nd	Season flooded	Y	P	P	U	>31	0	4	nd	>31	Ol/Fm	6.4	322
G13.01	08/27/96	63.996152	-146.677532	1036	Upland	11	10	180	1	>-35	Upland	N	E	A	U	>35	0	0	R	4	Gfm		
G13.03	08/27/96	63.99376	-146.680487	1006	Lowland	11			36	>-50	Temp flooded	N	W	P	P	>50	9	9	R	20	Om/Gfm	5	51
G15.00	08/30/96	63.751379	-146.424788	869	Glaciated	622	8	360	23	nd	Upland	N	nd	nd	U	nd	0	0	RE	0	B		
G15.01	08/27/96	63.753244	-146.426773	853	Glaciated	622	22	180	21	>-25	Upland	N	E	A	U	>25	0	0	RE	0	B	6.5	20
G15.02	08/27/96	63.757404	-146.42975	838	Glaciated	622	20	180	21	>-19	Upland	N	E	nd	U	>19	nd	nd	RE	0	Rm	5.7	90
G15.03	08/27/96	63.756787	-146.426733	861	Glaciated	622	0.0	0.0	1	>-30	Upland	N	W	A	U	>30	20	20	RE	20	Om/B	5.8	20
G16.01	08/30/96	63.791358	-146.11525	739	Glaciated	622	6	90	56	>-56	Upland	N	W	A	U	>56	0	0	L	>56	Fgm	6.1	20
G16.02	08/30/96	63.790562	-146.12053	747	Glaciated	622	1	>-17			Upland	N	E	A	U	>17	0	0	R	17	Fm/Rm	6.3	14
G16.03	08/30/96	63.789219	-146.118331	739	Glaciated	622	2	180	50	- 5	Saturated	Y	P	P	P	43	24	24	L	>43	Om/Fgm	5.3	590
G16.04	08/30/96	63.788612	-146.117415	739	Lacustrine	854	0.0	0.0	86	5	Semi-perm flooded	Y	P	P	A	>80	40	40	R	40	Om/Gfm	6.4	30
G16.05	08/30/96	63.79067	-146.108158	754	Glaciated	622	16	135	21	>-45	Upland	N	W	nd	U	>45	4	4	R	12	Fom/Fgm	5.2	20
G16.06	08/30/96	63.790604	-146.112361	747	Glaciated	622	2	225	56	>-38	Season flooded	N	W	P	U	>38	0	0	L	>38	Fgm	5.7	40
G17.01	08/30/96	63.992913	-145.988791	396	Lowland	715	0.0	0.0	71	- 30	Saturated	Y	W	P	P	49	16	23	L	>49	Om/Ol/Fm	4.9	130
G17.02	08/30/96	63.991891	-145.990895	396	Lowland	715	0.0	0.0	71	>-38	Upland	N	W	P	P	71	7	13	L	>71	Ol/Fm	5.2	750
G17.03	08/30/96	63.991080:	-145.987972	396	Lowland	715	0.0	0.0	71	- 17	Saturated	Y	P	P	P	41	9	29	L	nd	Om/Ol	5.9	80
G17.04	08/30/96	63.991778	-145.98846	396	Lowland					nd	nd	Y	nd	nd	U	nd	nd	nd	nd	nd	nd		
G18.01	08/30/96	64.021311	-146.183426	451	Lowland	888	56	- 5			Saturated	Y	P	P	P	48	>48	40	O	>48	Om	5.9	90
G18.02	08/30/96	64.021174	-146.181089	451	Lacustrine	854	0.0	0.0	86	0	Semi-perm flooded	Y	P	nd	A	>250	>94	40	O	>250	Om	6.2	220
G18.03	08/30/96	64.021982	-146.179545	451	Lowland	888	2	270	50	- 15	Saturated	Y	P	P	P	30	>30	>30	nd	>30	Om	5.5	180
G18.04	08/30/96	64.021269:	-146.175657	460	Upland	372	0.0	0.0	27	>-62	Upland	N	W	A	A	>62	5	6	L	62	Fm/Gfm	6	20
G18.05	08/30/96	64.020468	-146.17291	451	Lacustrine	854	0.0	0.0	86	10	Semi-perm flooded	Y	P	P	A	>250	60	40	L	>250	Om/Fm	5.75	45
G18.05a	08/15/98	64.0164	-146.22593:	473	Lacustrine	750	0.0	0.0	86	15	Semi-perm flooded	Y	F	P	A	>110	3	5	L	>110	Ol/Fm		
G18.06	08/30/96	64.021093	-146.17218	451	Lacustrine	750	86	>-65			Upland	N	P	P	A	>230	3	3	L	230	Fm/Gfm	5.9	70
G18.06a	08/15/98	64.014861	-146.221753	479	Glaciated	621	2	90	22	>-100	Upland	N	W	A	A	>100	6	6	L	50	Fm/Sm/Fgm/Gfm		
G18.07	08/30/96	64.022012	-146.168755	454	Upland	372	2	270	27	nd	nd	ND	nd	nd	A	>200	nd	nd	L	>200	Fm	5.4	120
G18.13	08/15/98	64.010217	-146.246333	442	Floodplain	481	0.0	0.0	90	20	Perm flooded	Y	nd	nd	A	>150	0	0	RE	0			
G18.14	08/15/98	64.010331:	-146.247994	443	Floodplain	445	0.0	0.0	71	>-50	Season flooded	N	W	A	A	>150	2	2	S	33	Fl/Sl/Gm/Sl	6.5	10
G18.15	08/15/98	64.009755	-146.249333	444	Floodplain	447	0.0	0.0	71	>-80	Upland	N	W	A	A	>80	1	5	L	72	Ol/Fl/Gm	5	70

Alaska Veg Class	Dominant Species	EcoType Group
Open Black Spruce Forest	picmar/betnan-ledgro/sphagnum	Lowland Wet Needleleaf Forest
Open Black Spruce Forest	picmar/ledgro-vaculi/plesch	Lowland Wet Needleleaf Forest
Black Spruce Woodland	picmar/erivag	Lowland Tussock Scrub Bog
Open Spruce–Paper Birch Forest	betpap-picmar/alnten/vaculi-equsyl/vacvit/plesch	Riverine Moist Mixed Forest
Subarctic Lowland Sedge–Shrub Wet Meadow	eriang-leddec-betnan/vacvit/sphagsp.	Lowland Fen Meadow
Black Spruce Woodland	picmar/erivag-ericaceous/plesch	Lowland Wet Needleleaf Forest
Open Low Mixed Shrub–Sedge Tussock Bog	erivag-alncri-betnan/empnig	Lowland Tussock Scrub Bog
Spruce–Paper Birch Woodland	picmar-betpap/leddec-erivag-ledgro-betnan	Lowland Wet Low Scrub
Closed Low Shrub Birch–Ericaceous Shrub	betgla-vaculi/sphagsp.	Lowland Wet Low Scrub
Subarctic Lowland Sedge Wet Meadow	caraqu-eriang	Riverine Wet Meadow
Open Low Mixed Shrub–Sedge Tussock Bog	erivag-betnan/rubcha/sphagnum	Lowland Tussock Scrub Bog
Open Low Ericaceous Shrub Bog	rubcha-erivag-empnig/sphagsp.	Lowland Dwarf Scrub Bog
Dryas Dwarf Shrub Tundra	Drydru-Popbal-Oxycam-Fravir-Astsib	Riverine Gravelly Dry Dwarf Scrub
Open Spruce–Balsam Poplar Forest	Popbal-Picgla/Shecan/Drydru/Cerpur	Riverine Gravelly Dry Mixed Forest
Water (<5% vegetated)	Upper Perennial River	River or Stream
Closed White Spruce Forest	Picgla/Geoliv-Vacvit/Rhytri-Hylspl	Lowland Gravelly Needleleaf Forest
Open White Spruce Forest	Picgla/Shecan/Arcuva/Hylspl-Stereocaulon-Lichens	Lowland Gravelly Needleleaf Forest
Open Quaking Aspen–Spruce Forest	Picgla-Poptre-Popbal/Shecan/Arcuva/Claarb	Lowland Gravelly Dry Mixed Forest
Closed Spruce–Paper Birch Forest	Picgla-Betpap/Alncri/Hylspl	Upland Moist Mixed Forest
Closed Quaking Aspen Forest	Poptre-Picgla/Shecan-Vibedu	Upland Rocky Dry Broadleaf Forest
Midgrass–Herb	Potmul-Calpur/Crustose Lichens	Upland Rocky Dry Meadow
Closed Quaking Aspen Forest	Poptre-Picgla/Shecan-Rosaci	Upland Rocky Dry Broadleaf Forest
Open Paper Birch Forest	Betpap/Alncri/Rosaci-Calcan	Upland Moist Broadleaf Forest
Closed White Spruce Forest	Picgla/Hylspl	Upland Moist Needleleaf Forest
Sagebrush–Grass	Artfri-Poptre-Juncom/Mosses-Lichens	Upland Rocky Dry Meadow
Closed Spruce–Quaking Aspen–Balsam Poplar Forest	Poptre-Picgla-Popbal/Shecan-Ledgro/Vacvit	Lowland Gravelly Dry Mixed Forest
Open Low Mixed Shrub–Sedge Tussock Bog	betgla-erivag-leddec-vaculi	Lowland Tussock Scrub Bog
Subarctic Lowland Sedge Wet Meadow	eriang-caraqu	Lowland Fen Meadow
Black Spruce Woodland	picmar/leddec-erivag/empnig-vacvit/mosses	Lowland Wet Needleleaf Forest
Closed Spruce–Paper Birch Forest	betpap-picgla/alnten/equarv-equsyl-polala/rhytri	Riverine Moist Mixed Forest
Closed Paper Birch Forest	Betpap-Picgla/Calcan-Vibedu-Rosaci/Corcan	Lowland Wet Broadleaf Forest
Black Spruce Dwarf Tree Woodland	Picmar/Ledpal/Rubcha-Oxymic-Empnig/Sphag	Lowland Dwarf Scrub Bog
Open Low Ericaceous Shrub Bog	Carbig/Rubcha-Empnig-Oxymic/Sphagnum	Lowland Dwarf Scrub Bog
Barren (<5% vegetated)	drydru-oxycam-salala-popbal	Riverine Gravelly Barrens
Closed Spruce–Paper Birch Forest	betpap-picmar/calcan/vacvit/hylspl	Lowland Wet Mixed Forest
Open Low Alder Shrub	alncri-betnan-leddec-carbig/vacvit/mosses	Alpine Rocky Moist Low Scrub
Closed Quaking Aspen Forest	poptre/vibedu-shecan/arcuva	Upland Rocky Dry Broadleaf Forest
Bluejoint–Shrub	calcan-betpap-ledgro-rosaci/equsyl	Upland Moist Meadow
Open Low Willow Shrub	salpul-calcan/potpal	Lowland Wet Low Scrub
Dryas–Lichen Dwarf Shrub Tundra	dryoct-betnan/lichens	Alpine Rocky Dry Dwarf Scrub
Closed Low Willow Shrub	salpul-salarb/calcan	Alpine Rocky Moist Low Scrub
Barren (<5% vegetated)	barren	Alpine Rocky Dry Barrens
Partially Vegetated (>5,<30% cover)	calpur-hedmac-alnten-salint-shecan	Alpine Rocky Dry Barrens
Closed Tall Alder Shrub	alncri/ribtri	Upland Rocky Dry Low Scrub
White Spruce Woodland	picgla/empnig-vaculi-alncri-salixspp/stersp.	Upland Rocky Dry Low Scrub
Hair-grass	descae-carsax-caraqu	Lowland Moist Meadow
Open Low Mesic Shrub Birch–Ericaceous Shrub	betgla-vaculi/arcuva	Upland Rocky Dry Low Scrub
Open Low Shrub Birch–Ericaceous Shrub Bog	vaculi-betnan-salpul/carbig-empnig/mosses	Lowland Wet Low Scrub
Subarctic Lowland Sedge Wet Meadow	caraqu-eriang	Lacustrine Fen Meadow
Fireweed	epiang-calcan-alncri-vaculi	Upland Moist Low and Tall Scrub disturbed
Subarctic Lowland Sedge Moist Meadow	carsax-junarc	Lowland Moist Meadow
Open Black Spruce Forest	picmar/ledgro-betgla/vacvit-equarv/hylspl	Lowland Wet Needleleaf Forest
Closed Paper Birch Forest	betpap/salbeb/rosaci-calcan/equsyl-pyrgra	Lowland Wet Broadleaf Forest
Spruce–Paper Birch Woodland	betpap-picgla/betgla/erivag-caraqu	Lowland Wet Low Scrub
Open Low Mixed Shrub–Sedge Tussock Bog	nd	Lowland Tussock Scrub Bog
Open Low Mixed Shrub–Sedge Tussock Bog	betgla-erivag-vaculi/mosses	Lowland Tussock Scrub Bog
Subarctic Lowland Sedge Wet Meadow	caraqu-carros	Lacustrine Fen Meadow
Open Black Spruce Forest	picmar/ledgro-vaculi/vacvit/hylspl	Lowland Wet Needleleaf Forest
Closed Paper Birch Forest	betpap/hylspl	Upland Moist Broadleaf Forest
Subarctic Lowland Sedge Wet Meadow	caraqu-carros-equflu	Lacustrine Fen Meadow
Subarctic Lowland Sedge Wet Meadow	carlas-eriang	Lacustrine Fen Meadow
Bluejoint–Shrub	calcan-salbeb	Lacustrine Moist Meadow
Closed Paper Birch Forest	betpap-picmar/calcan/hylspl	Upland Moist Broadleaf Forest
Closed Paper Birch Forest	betpap/alncri/calcan-equsyl	Upland Moist Broadleaf Forest
Water (<5% vegetated)		Upper Perennial River
Closed Balsam Poplar–White Spruce Forest	popbal-picgla/alncri-alnten/vibedu-rosaci	Riverine Moist Mixed Forest
Closed White Spruce Forest	Picgla/Alnten/Equarv/Rhytri-Hylspl	Riverine Moist Needleleaf Forest

Table B1 *(cont'd)*. Data file listing environmental characteristics of ground-reference plots, Fort Greely, Alaska, 1999.

Plot name	Date	Latitude (NAD27)	Longitude (NAD27)	Elevation (m)	Physiography	Geomorph	Slope (deg)	Aspect (deg)	Surface form	Water depth (cm)	NWI-Water Regim	Sat 30 cm (Y,N,ND)	Drainage general	Hydr soil (present,absent)	Permafrost (present,absent, unknown)	Thaw depth (cm)	SurfOrgDepth (cm)	CumOrg40 (cm)	DomMinTe (0–50 cm)	GravDep (cm)	Lithosequence	pH	EC
G18.17	08/15/98	64.011811	-146.24652:	442	Lacustrine	750	0.0	0.0	79	>-80	Upland	y	W	P	A	>130	0	1	L	>130	Fm/Fl	5.9	20
G2.01	07/24/96	63.921077	-146.78432	663	Floodplain	483	0.0	0.0	70	>-36	Upland	N	W	A	A	>36	11	11	S	>36	Om/Fl		
G2.03	07/24/96	63.918157:	-146.788028	668	Lowland	888	0.0	0.0	56	- 2	Saturated	Y	P	P	P	46	>46	40	O	>46	Om	5.7	40
G2.04	07/24/96	63.913822	-146.811563	701	Glaciated	622	0.0	0.0	1	>-33	Upland	N	W	A	A	>33	2	2	R	9	Fm/Rfm	4.5	
G2.05	07/24/96	63.914277	-146.786848	678	Glaciated	622	56	- 40			Upland	N	nd	P	U	>40	10	10	R	10	Om/Gfm		
G2.06	07/24/96	63.908755	-146.805853	709	Glaciated	622	0.0	0.0	1	>-21	Upland	N	W	A	U	>21	3	3	R	17	Fm/Gfm		
G2.07	07/24/96	63.915025	-146.786976	678	Glaciated	622	0.0	0.0	40	>-32	Upland	N	W	P	A	>32	3	3	R	3	Gfm		
G2.08	07/24/96	63.908751	-146.80272	730	Glaciated	622	0.0	0.0	1	>-56	Upland	N	W	A	A	>56	4	4	R	18	Rfm		
G20.01	08/20/98	63.790245:	-145.787966	765	Upland	12	33	38	13	>-23	Upland	N	W	A	U	>23	14	14	RE	23	Om/Fm/B		
G20.13	08/20/98	63.788617	-145.794623	803	Upland	12	37	290	12	>-23	Saturated	Y	W	P	P	>23	8	9	RE	20	Ol/B	5.5	60
G21.01	09/02/96	63.845649	-145.686807	506	Floodplain	712	0.0	0.0	71	>-41	Upland	N	W	A	U	>41	3	5	S	41	Ol/Sm	7.17	60
G21.02	09/02/96	63.845393	-145.687633	506	Floodplain	711	0.0	0.0	71	>-22	Upland	ND	W	A	U	nd	0	0	R	22	Fl/Gfm	7.4	80
G21.03	09/02/96	63.844939	-145.689848	507	Lowland	452	0.0	0.0	71	>-35	Upland	N	W	A	U	>35	9	12	L	35	Om/Fl/Gm	6.16	30
G21.04	09/02/96	63.844897:	-145.69184	507	Lowland	452	0.0	0.0	71	>-37	Upland	N	W	A	U	>37	14	17	L	37	Om/Ol/Fl/Gm	5.78	30
G21.05	09/02/96	63.846335	-145.699869	507	Lowland	452	2	90	50	- 13	Saturated	Y	P	P	P	32	9	14	L	>32	Om/Fl		
G22.01	09/02/96	63.936361	-145.517231	419	Lowland	715	0.0	0.0	71	>-50	Upland	N	nd	A	A	nd	5	5	L	39	Fm/Fgm/Gfm	5.54	50
G22.02	09/02/96	63.937398:	-145.522358	419	Lowland	715	0.0	0.0	71	>-60	Upland	N	nd	A	A	>60	1	1	L	48	Fm/Gfm	5.5	20
G22.03	09/02/96	63.941772:	-145.532268	418	Glaciated	621	0.0	0.0	1	>-35	Upland	N	W	A	A	>35	2	2	R	20	Fm/Gfm	6.19	20
G22.11	08/27/98	63.944975	-145.502917	402	Lowland	705	0.0	0.0	71	>-15	Upland	N	W	A	A	>15	2	2	R	6	5	20	
G22.15	08/27/98	63.948819	-145.519968	406	Lowland	872	0.0	0.0	56	-51	Saturated	Y	P	P	P	51	57	40	O	>51	5.6	50	
G22.20	08/27/98	63.929517	-145.546583	431	Glaciated	621	5	130	27	>-35	Upland	N	W	A	U	>35	5	5	R	22	Fm/Gfm	5.6	10
G22.21	08/27/98	63.93771	-145.533157	416	Upland	372	3	130	27	>-33	Upland	N	W	A	U	>33	2	2	L	33	5.8	10	
G22.22	08/27/98	63.945833	-145.51434:	404	Lacustrine	750	0.0	0.0	56	>-130	Upland	N	W	A	A	>130	8	8	L	>130	5.6	120	
G23.01	09/02/96	63.972454	-145.650005	404	Floodplain	712	0.0	0.0	70	>-40	Upland	N	E	A	A	>40	0	0	RE	7	Gfm	7.07	60
G23.02	09/02/96	63.972988	-145.651366	404	Floodplain	712	0.0	0.0	71	>-40	Upland	N	E	A	A	>40	1	1	RE	14	Ol/Gm	7.09	50
G23.03	09/02/96	63.972199	-145.645155	404	Floodplain	712	0.0	0.0	71	>-80	Upland	N	W	A	A	>80	2	4	L	68	Ol/Fm/Gfm	6.68	60
G23.04	09/02/96	63.975847	-145.64853	404	Floodplain	712	0.0	0.0	71	>-100	Upland	N	W	A	A	>100	8	10	L	81	Ol/Fm/Gfm	6.53	20
G23.05	09/02/96	63.97166	-145.640446	404	Lowland	715	0.0	0.0	71	>-40	Upland	N	W	A	A	>150	4	5	L	150	Ol/Fm/Gfm	6.54	60
G25.01	08/17/98	64.067148	-146.57380:	541	Lowland	371	0.0	0.0	50	>-48	Saturated	Y	P	P	P	48	23	23	L	>48	Om/Fomt	4.6	20
G25.20	08/17/98	64.074267	-146.5634	545	Upland	888	0.0	0.0	18	~-80	Saturated	Y	W	P	A	>110	40	40	O	110	Om		
G25.24	08/17/98	64.067677	-146.583541	548	Lowland	371	2	180	41	-28	Saturated	Y	P	P	P	118	28	28	L	>118	Om/Fm		
G28.04b	08/16/98	64.109304	-146.387112	384	Floodplain	447	0.0	0.0	71	>-57	Upland	N	W	A	A	>57	2	2	S	57	Sm		
G28.05	08/16/98	64.10752	-146.386868	385	Floodplain	447	0.0	0.0	71	>-42	Upland	N	E	A	A	>55	0	0	R	4	Gl	7.4	20
G3.01	07/25/96	63.779632	-146.278574	1113	Upland	888	2	45	2	- 5	Upland	Y	P	P	P	>28	>28	>28	nd	>28	Om		
G30.01	09/02/96	64.023646	-145.743	358	Floodplain	712	0.0	0.0	71	>-53	Upland	N	W	A	A	>53	4	4	S	53	Fl/Gfm	8.05	80
G30.02	09/02/96	64.026607	-145.740192	360	Floodplain	712	0.0	0.0	71	>-32	Upland	N	W	A	A	>150	0	3	S	>150	Ol/Fl	7.18	50
G30.03	09/02/96	64.026637	-145.742086	355	Floodplain	702	0.0	0.0	76	nd	nd	ND	E	nd	A	nd	0	0	R	0	Gfm		
G30.08	08/28/98	64.017576	-145.719342	363	Lowland	374	0.0	0.0	71	>-59	Upland	N	W	A	A	>59	2	2	L	59	6.8	30	
G30.12	08/28/98	64.013697	-145.709903	364	Floodplain	447	0.0	0.0	71	>-58	Upland	N	P	A	U	>58	6	8	L	58	Ol/Fm	6.5	60
G30.15	08/28/98	64.016816:	-145.727917	359	Floodplain	447	0.0	0.0	71	>-130	Upland	N	P	A	A	>130	7	13	S	>130	Ol/Fm/Sm	5.8	40
G33.03	08/18/98	63.795155:	-146.291343	1021	Upland	330	9	140	16	-20	Saturated	Y	P	P	P	45	40	40	O	>45	Om	6.1	30
G33.06	08/18/98	63.792066	-146.293735	987	Floodplain	482	7	75	70	-5	Season flooded	y	P	P	U	>80	1	1	S	47	Sm		
G33.12a	08/18/98	63.789867	-146.31085	1037	Lowland	843	3	90	70	15	Semi-perm flooded	Y	P	P	A	>130	130	40	O	>130	Om	6.1	10
G33.12b	08/18/98	63.789617	-146.316583	1047	Lowland	874	1	90	57	-5	Saturated	Y	P	P	P	100	>45	40	O	>130	Om	5.7	10
G33.21a	08/18/98	63.785706	-146.248769		Upland	330	14	162	16	-18	Saturated	Y	W	P	P	114	5	5	R	13	5.2	30	
G33.24	08/18/98	63.786449:	-146.258483	1093	Glaciated	621	6	12	23	-10	Saturated	Y	P	P	P	45	33	33	L	>45	Om/Fmg	4.9	90
G33.27	08/18/98	63.791983	-146.270233	966	Lowland	330	10	326	38	-24	Saturated	Y	P	P	P	55	21	21	L	48	Om/Fgm	5	140
G33.30	08/18/98	63.79835	-146.271817	882	River	911	0.0	0.0	94	30	Perm flooded	Y	nd	nd	nd	nd	nd	nd	nd	nd	nd	7	30
G33.31	08/18/98	63.798883	-146.300233	1021	Glaciated	621	0.0	0.0	1	>-50	Upland	nd	nd	A	U	>50	0	0	RE	0			
G34.18	08/18/98	63.721942	-146.071877	686	Glaciated	622	4	33	20	-40	Saturated	Y	P	P	A	>90	18	18	L	90	Om/Fom	5.9	50
G34.20	08/18/98	63.716372:	-146.102078	865	Glaciated	622	8	160	56	>-130	Upland	N	W	A	A	>130	3	3	R	0	?	5.9	10
G34.22	08/18/98	63.718444:	-146.08862	777	Glaciated	622	0.0	0.0	37	-55	Saturated	Y	P	P	P	56	18	18	L	>56			
G35.01	08/21/98	63.860072:	-145.613251	507	Upland	372	0.0	0.0	1	>-45	Upland	N	W	A	U	>45	3	3	L	45	Fm/Gm		
G35.01b	08/21/98	63.864883	-145.600467	493	Lacustrine	885	0.0	0.0	56	-80	Season flooded	N	P	P	A	>100	19	39	L	100	Om/Ol/Fm	5.2	30
G35.04	08/21/98	63.861122:	-145.592129	494	Lowland	371	1	170	61	-60	Saturated	Y	P	P	A	>130	20	20	L	>130	4.8	30	
G35.07	08/21/98	63.860401	-145.575308	486	Glaciated	621	0.0	215	26	>-20	Upland	N	W	A	A	>20	9	9	R	10	Om/Gfm	5.2	10
G35.13	08/21/98	63.848419	-145.595186	519	Glaciated	621	2	340	33	>-65	Upland	N	W	A	U	>65	8	8	R	16	Om/Gfm		
G36.01	08/26/98	63.896161:	-145.768557	484	Lowland	715	0.0	0.0	71	-48	Saturated	Y	P	P	P	68	16	16	S	>68	Om/Fl/Sm	5.5	20
G36.06	08/26/98	63.887975	-145.748622	487	Lowland	705	0.0	0.0	78	>-16	Upland	nd	W	A	U	>16	11	11	RE	16	Om/Gfm	5.1	10
G36.07	08/26/98	63.883532	-145.743984	493	Lowland	705	0.0	0.0	70	>-109	Upland	N	W	A	A	>109	11	11	R	29	Om/Fm/Gm	5.1	40
G36.08	08/26/98	63.881001	-145.735372	498	Lowland	705	0.0	0.0	61	np	Saturated	Y	P	P	A	>130	6	6	R	6	Gfm		
G36.09	08/26/98	63.882559:	-145.749428	496	Lowland	715	0.0	0.0	71	>-58	Upland	N	W	A	U	>58	17	17	R	30	Om/Gfm	4.8	30
G40.01	09/11/96	64.023338	-145.69711:	363	Floodplain	712	0.0	0.0	71	nd	Upland	N	nd	nd	U	nd	nd	nd	nd	nd	nd		
G40.02	09/11/96	64.022828:	-145.699879	363	Floodplain	712	0.0	0.0	71	nd	Upland	ND	nd	nd	U	nd	nd	nd	nd	nd	nd		
G40.02a	08/25/98	63.791567	-145.815723	732	Glaciated	621	0.0	300	50	>-49	Upland	N	W	A	P	>49	11	11	L	>49	Om/Fgm	5.3	30
G40.03	09/11/96	63.990330:	-145.636515	390	Lowland	0.0	0.0	71	nd		Upland	ND	nd	nd	U	nd	nd	nd	nd	nd	nd		
G40.03a	08/25/98	63.78947	-145.815482	731	Lowland	330	2	340	50	-34	Saturated	Y	P	P	U	>86	14	22	L	50	Om/Ol/Gfm	4.7	40
G40.04	09/12/96	63.989372:	-145.633838	390	Lowland	0.0	0.0	71	nd		Upland	ND	nd	nd	U	nd	nd	nd	nd	nd	nd		

Alaska Veg Class	Dominant Species	EcoType Group
Bluejoint Meadow	calcan	Lacustrine Moist Meadow
Closed Spruce–Paper Birch Forest	betpap-picgla/vibedu	Riverine Moist Mixed Forest
Open Low Mixed Shrub–Sedge Tussock Bog	erivag/empnig/sphagnum	Lowland Tussock Scrub Bog
Open Paper Birch–Quaking Aspen Forest	betpap-poptre/betgla-vaculi	Upland Rocky Dry Broadleaf Forest
Bluejoint Meadow	calcan	Lowland Moist Meadow
Spruce–Paper Birch Woodland	betpap-picmar/betgla-vaculi/polytsp.-cladinsp.	Upland Rocky Dry Low Scrub
Black Spruce Woodland	picmar/leddec-vaculi-betgla/vacvit	Lowland Low Scrub disturbed
Open Low Mesic Shrub Birch–Ericaceous Shrub	vaculi-betgla/arcalp/polysp.	Upland Rocky Dry Low Scrub
Closed Low Alder–Willow Shrub	Alncri-Salgla-Salpul/Arclat	Alpine Rocky Moist Low Scrub
Closed Tall Alder–Willow Shrub	Alncri-Salpul-Salgla/Arttil-Arclat/Lycann	Upland Moist Low and Tall Scrub
Open Spruce–Balsam Poplar Forest	popbal-picgla/alnten/calasp.-shecan-potfru	Riverine Moist Mixed Forest
Open Balsam Poplar Forest	popbal-salspp./calpur-elacom/oxytsp.	Riverine Gravelly Low and Tall Scrub
Open Black Spruce–White Spruce Forest	picmar-picgla/vaculi-ledgro/vacvit/hylspl	Lowland Wet Needleleaf Forest
Open Black Spruce Forest	picmar-picgla/vacvit/hylspl	Lowland Wet Needleleaf Forest
Black Spruce Woodland	picmar/vaculi-betgla-salpul/tomnit-hylspl	Lowland Wet Low Scrub
Open Tall Willow Shrub	salbeb/fesalt/calpur	Lowland Moist Tall Scrub
Closed Quaking Aspen–Spruce Forest	poptre/picmar/vacvit/mosses	Lowland Gravelly Dry Broadleaf Forest
Closed Spruce–Paper Birch–Quaking Aspen Forest	picmar-poptre-betpap/salbeb/vacvit	Upland Moist Mixed Forest
Fireweed	Epiang-Fesalt-Poptrem/Linbor-Corcan/Polytrichum	Lowland Low Scrub disturbed
Open Low Mixed Shrub–Sedge Tussock Bog	Erivag-Betnan-Ledduc-Chacal/Mosses	Lowland Tussock Scrub Bog
Closed Paper Birch Forest	betpap/picgla	Upland Rocky Dry Broadleaf Forest
Open Quaking Aspen Forest	Poptre-Picmar/Ledgro/vacvit	Upland Moist Broadleaf Forest
Mesic Mixed Herbs	Rummar-Sencon	Lacustrine Moist Meadow
Midgrass–Herb	agrsub-fesbra-potspp./mosses	Riverine Gravelly Dry Meadow
Open Balsam Poplar Forest	popbal/potfru-sheca/elymsp.	Riverine Gravelly Dry Broadleaf Forest
Closed Quaking Aspen–Balsam Poplar Forest	popbal-poptre-picgla/geoliv-linbor	Riverine Moist Broadleaf Forest
Closed White Spruce Forest	picgla/hylspl	Riverine Moist Needleleaf Forest
Black Spruce–White Spruce Woodland	picgla-picmar/ledgro-betgla-potfru	Lowland Wet Needleleaf Forest
Open Low Mixed Shrub–Sedge Tussock Bog	Erivag-Alncri-Betnan-Leddec/Sphag	Lowland Tussock Scrub Bog
Open Low Shrub Birch–Ericaceous Shrub Bog	Alncri/Vaculi-Betnan-Erivag-Ledduc/Rubcha	Lowland Wet Low Scrub
Open Low Shrub Birch–Ericaceous Shrub Bog	Ledgro-Vaculi-Picmar-Betnan/Equsyl/Mosses	Lowland Wet Low Scrub
Open White Spruce Forest	Picgla-Popbal/Hylspl	Riverine Moist Needleleaf Forest
Balsam Poplar Woodland	Popbal/Drydru-Arcuva	Riverine Gravelly Dry Dwarf Scrub
Tussock Tundra	carbig-erivag/empnig-betnan-vaculi	Alpine Wet Tussock Meadow
Open Spruce–Balsam Poplar Forest	popbal-picgla/rosaci/fravir-elyinn	Riverine Moist Mixed Forest
Open White Spruce Forest	picgla/ledgro-shecan/equarv	Riverine Moist Needleleaf Forest
Barren (<5% vegetated)	barren	Riverine Gravelly Barrens
Closed Quaking Aspen–Balsam Poplar Forest	Popbal-Poptre/Epiang/Fraviv-Arcuva	Lowland Gravelly Dry Broadleaf Forest
Closed Spruce–Paper Birch–Quaking Aspen Forest	Picgla-Poptre-Betpap-Popbal/Vibedu/Hylspl	Riverine Moist Mixed Forest
Closed Quaking Aspen Forest	Poptre/Rosaci/Calcan-Equarv-Epiang	Riverine Moist Broadleaf Forest
Closed Low Shrub Birch–Willow Shrub	salpul-betnan-vaculi/carbig/hylspl	Alpine Wet Low Scrub
Closed Low Willow Shrub	salpul/vaculi/equarv/hylspl	Alpine Wet Low Scrub
Wet Sedge Meadow Tundra	Caraqu-Eriang-Erirus	Alpine Wet Meadow
Open Low Willow–Graminoid Shrub Bog	Salfus-Caraqu/Sphag	Alpine Wet Low Scrub
Open Tall Alder Shrub	Alncri/Calcan-Vaculi-Betnan-Petfri	Alpine Rocky Moist Low Scrub
Tussock Tundra	Erivag-Betnan-Vaculi-Carbig	Alpine Wet Tussock Meadow
Closed Low Shrub Birch–Ericaceous Shrub	Betnan-Leddec-Vaculi-Salpul/Hylspl-Sphag	Alpine Wet Low Scrub
Water (<5% vegetated)	Upper Perennial River	River or Stream
Dryas–Lichen Dwarf Shrub Tundra	Dryoct-Arcrub-Oxynig-Salarc/Lichens	Alpine Rocky Dry Dwarf Scrub
Closed Tall Alder Shrub	Alncri/Equsyl-Calcan/Lycann	Upland Moist Low and Tall Scrub
Fireweed	Epiang-Calsp.-Luzruf-Salgla/Polytrichum-Cerpur	Lowland Low Scrub disturbed
Open Low Shrub Birch–Ericaceous Shrub Bog	Vaculi-Betnan-Ledgro/Carbig-Erivag	Lowland Wet Low Scrub
Open Low Scrub (post burn, disturbance)	ledgro-calcan-vaculi/linbor/cerpur	Upland Moist Low and Tall Scrub disturbed
Bluejoint–Shrub	Calcan-Compal-Betnan-Salsp./Sphagnum	Lacustrine Moist Meadow
Open Low Shrub Birch–Ericaceous Shrub Bog	Vaculi-Ledgro-Betnan/Arclat-Carbig-Vacvit/Polytrichum-Sp	Lowland Wet Low Scrub
Open Low Scrub (post burn, disturbance)	Vaculi-Salgla-Poptre-Ledgro/Vacvit/Polytrichum	Upland Moist Low and Tall Scrub disturbed
Open Low Scrub (post burn, disturbance)	Vaculi-Ledgro-Arclat/Polytrichum-Cerpur	Lowland Low Scrub disturbed
Closed Black Spruce Forest	Picmar/Vacvit/Hylspl-Cladinaspp/Polytrichum-Rhyrug	Lowland Wet Needleleaf Forest
Open Black Spruce Forest	Picmar/Vaculi-Betnan/Stereocaulon-Hylspl-Cladinasp.	Lowland Gravelly Needleleaf Forest
Open Quaking Aspen–Spruce Forest	Picgla-Picmar-Poptre/Hylspl	Lowland Gravelly Dry Mixed Forest
Open Low Mesic Shrub Birch–Ericaceous Shrub	Betnan-Vaculi-Poptre/Leddec/Hylspl	Lowland Wet Low Scrub
Open Black Spruce Forest	Picmar/Vaculi/Vacvit/Hylspl	Lowland Gravelly Needleleaf Forest
Closed Quaking Aspen–Spruce Forest	poptre-picgla-popbal/salbeb/hylspl	Riverine Moist Mixed Forest
Open White Spruce Forest	picgla-picmar/ledgro/mosses	Riverine Moist Needleleaf Forest
Open Tall Alder Shrub	Alncri/Carbig-Betnan-Arclat-Vaculi-Petfri/Salret	Lowland Moist Tall Scrub
Closed Black Spruce Forest	picmar/vaculi/mosses	Lowland Wet Needleleaf Forest
Open Low Mesic Shrub Birch–Ericaceous Shrub	Betnan-Carbig-Vaculi/Leddec/Hylspl-Lichens	Lowland Wet Low Scrub
Closed Spruce–Paper Birch–Quaking Aspen Forest	betpap-poptre-picgla/mosses	Lowland Wet Mixed Forest

Table B1 *(cont'd)*. Data file listing environmental characteristics of ground-reference plots, Fort Greely, Alaska, 1999.

Plot name	Date	Latitude (NAD27)	Longitude (NAD27)	Elevation (m)	Physiography	Geomorph	Slope (deg)	Aspect (deg)	Surface form	Water depth (cm)	NWI-Water Regim	Sat 30 cm (Y,N,ND)	Drainage general	Hydr soil (present,absent)	Permafrost (present,absent, unknown)	Thaw depth (cm)	SurfOrgDepth (cm)	CumOrg40 (cm)	DomMinTe (0–50 cm)	GravDep (cm)	Lithosequence	pH	EC
G40.05	09/12/96	63.989947:	-145.638355	390	Lowland	71	nd	Upland		ND	nd	nd	U	nd	nd	nd	nd	nd	nd				
G40.06	09/12/96	63.986913	-145.6558	396	Floodplain	712	0.0	0.0	71	nd	Upland	ND	nd	nd	U	nd	nd	nd	nd	nd	nd		
G40.07	09/12/96	63.986211	-145.666455	390	Floodplain	712	0.0	0.0	70	nd	Upland	ND	nd	nd	U	nd	nd	nd	nd	nd	nd		
G40.08	09/12/96	63.983034	-145.672534	392	Floodplain	712	0.0	0.0	71	nd	Upland	ND	nd	nd	U	nd	nd	nd	nd	nd	nd		
G40.08a	08/25/98	63.786371	-145.818319	754	Glaciated	621	8	310	50	>-84	Saturated	Y	W	P	U	>84	6	8	L	84	5.8	30	
G40.09	09/12/96	63.995202	-145.673042	386	Floodplain	712	0.0	0.0	70	nd	Upland	ND	nd	nd	U	nd	nd	nd	nd	nd	nd		
G40.11	08/25/98	63.789085	-145.836561	784	Lowland	330	0.0	140	31	-20	Saturated	Y	P	P	U	>52	10	10	L	56	Om/Fm		
G41.01	09/13/96	63.882159	-145.770966	511	Lowland	715	0.0	0.0	71	nd	nd	ND	nd	nd	U	nd	nd	nd	nd	nd	nd		
G41.02	09/13/96	63.817464	-145.744625	567	Lowland	715	0.0	0.0	71	nd	Upland	ND	nd	nd	U	nd	nd	nd	nd	nd	nd		
G41.03	09/13/96	63.817905	-145.751537	567	Lowland	715	0.0	0.0	71	nd	nd	ND	nd	nd	U	nd	nd	nd	nd	nd	nd		
G41.04	09/13/96	63.818434	-145.757316	567	Glaciated	621	2	90	50	nd	nd	ND	nd	nd	U	nd	nd	nd	nd	nd	nd		
G41.05	09/13/96	63.8203	-145.765985	613	Glaciated	621	5	90	27	nd	nd	ND	nd	nd	U	nd	nd	nd	nd	nd	nd		
G41.06	09/13/96	63.818215	-145.764687	613	Glaciated	621	5	90	27	nd	nd	ND	nd	nd	U	nd	nd	nd	nd	nd	nd		
G41.07	09/13/96	63.804187	-145.780936	719	Glaciated	621	2	0.0	2	nd	nd	ND	nd	nd	U	nd	nd	nd	nd	nd	nd		
G41.08	09/13/96	63.784148	-145.844528	846	Glaciated	621	2	70	2	nd	nd	ND	nd	nd	U	nd	nd	nd	nd	nd	nd		
G41.09	09/13/96	63.785004	-145.845452	846	Glaciated	621	5	70	37	nd	nd	ND	nd	nd	U	nd	nd	nd	nd	nd	nd		
G41.17	08/28/98	63.799022	-145.75355	594	Lowland	705	0.0	0.0	78	>-49	Upland	N	W	A	U	>49	3	3	R	21	Fom/Gfm	5.8	10
G43.01	08/19/98	63.729167	-145.967833	506	Floodplain	711	0.0	0.0	71	-79	Season flooded	N	E	A	A	>79	0	0	R	0	Gfm	8.3	350
G43.02	08/19/98	63.7293	-145.964967	507	Floodplain	711	0.0	0.0	71	~-100	Season flooded	N	W	P	A	nd	0	1	L	68	Fl/Gfm		
G43.03	08/19/98	63.729573	-145.972669	505	Floodplain	712	0.0	0.0	71	>-37	Upland	N	W	A	A	>37	3	4	S	37	Ol/Sl	6.3	30
G43.04	08/19/98	63.727717	-145.967433	507	Floodplain	712	0.0	0.0	71	>-100	Season flooded	N	E	A	A	>100	1	1	R	1	Sgm/Gm	6.9	40
G43.05	08/19/98	63.727817	-145.972333	508	Floodplain	712	0.0	0.0	71	nd	Upland	N	W	P	A	nd	7	7	R	22	Om/Sm/Gfm	6.2	20
G43.06	08/19/98	63.726183	-145.9727	509	Floodplain	712	0.0	0.0	71	>-50	Upland	N	E	A	A	>100	2	2	RE	4	Gm		
G43.08	08/19/98	63.724715	-145.977469	511	Floodplain	712	0.0	0.0	71	np	Upland	N	W	A	A	nd	2	2	R	4	Gfm	6.8	40
G43.09	08/19/98	63.724219	-145.971804	50:	Floodplain	712	0.0	0.0	71	>-105	Upland	N	nd	A	A	>105	3	4	L	105	Fm	5.5	30
G43.12	08/19/98	63.716199:	-145.968217	594	Upland	372	2	47	17	nd	Upland	N	W	A	P	120	36	36	L	>120	Om/Fm	3.9	90
G43.13	08/19/98	63.714683	-145.970583	625	Upland	373	10	80	22	>-50	Upland	N	W	A	P	61	14	16	L	>61	Ol/Fm	4.6	40
G43.14	08/19/98	63.713433	-145.974517	650	Upland	373	1	172	1	-44	Saturated	N	W	P	P	45	16	16	L	>45	Om/Fm	4.8	70
G43.17	08/19/98	63.708867	-145.9563	554	Upland	372	48	160	6	np	Upland	N	W	A	A	nd	1	1	L	56	Fm		
G43.18	08/19/98	63.7128	-145.95075	516	Floodplain	711	0.0	0.0	71	-92	Season flooded	N	W	P	A	nd	0	4	R	27	7.3	26	
G43.20	08/19/98	63.712222	-145.950185	516	Floodplain	712	0.0	0.0	71	nd	Upland	nd	E	A	A	>100	1	3	RE	5	Ol/Gm	6.5	40
G5.01	08/28/96	63.839049	-146.611378	1535	Upland	12	31	175	1	>-35	Upland	N	E	A	U	>35	0	0	RE	2	Rm	5.6	70
G5.02	08/29/96	63.845321	-146.569791	838	Floodplain	483	71	31	71	>-90	Upland	N	W	A	A	>90	0	5	L	>90	Fl/Ol/Fl/Sm	5.9	176
G5.03	08/29/96	63.822907	-146.590921	1402	Upland	11	8	190	21	>-15	Upland	N	W	A	U	>15	0	0	RE	0	Gm	5	110
G5.04	08/29/96	63.820118	-146.594911	1325	Lowland	520	4	190	46	- 10	Saturated	Y	P	P	P	>29	8	8	R	29	Fl/Gfm	4.9	30
P1.01	07/20/96	64.116107	-146.73708	468	Lowland	520	0.0	0.0	43	>-31	Saturated	Y	P	P	P	29	31	31	L	>58	Om/Fgm	4.5	
P1.02	07/20/96	64.116688	-146.736349	465	Lowland	888	2	0.0	32	- 11	Saturated	Y	P	P	P	26	40	40	O	>40	Om	5	25
P1.03	07/20/96	64.117585:	-146.735735	461	Lowland	888	37	- 10			Saturated	Y	P	P	A	160	60	40	O	>60	Om	5.05	
P1.04	07/20/96	64.118338:	-146.736125	460	Lowland	888	0.0	90	50	- 18	Saturated	Y	P	P	A	121	121	40	O	>121	Om	4.95	50
P1.04A	07/20/96	64.119480:	-146.734624	460	Lowland	520	0.0	180	46	- 22	Saturated	Y	P	P	P	97	14	14	S	>38	Om/Fgm	5.3	10
P1.05	07/20/96	64.120127:	-146.734069	459	Lowland	520	0.0	0.0	45	>-68	Upland	N	W	A	A	>134	12	12	S	>126	Om/Fgmt	4.5	
P1.06	07/21/96	64.121021:	-146.733994	456	Lowland	520	0.0	0.0	48	>-19	Saturated	Y	P	P	P	19	19	19	L	>96	Om/Fl	5	
P1.07	07/21/96	64.121815	-146.733495	453	Lowland	888	0.0	45	50	- 18	Saturated	Y	P	P	P	29	62	40	O	>62	Om	5.15	40
P2.01	07/23/96	63.913742	-146.800189	723	Glaciated	622	0.0	0.0	61	- 17	Saturated	Y	P	P	P	33	31	31	L	>38	Om/Rfm	5.05	30
P2.02	07/23/96	63.914419:	-146.798187	708	Glaciated	622	5	315	23	- 14	Saturated	Y	P	P	U	>63	23	23	L	>63	Om/Fgm	4.9	40
P2.02A	07/23/96	63.91523	-146.796802	686	Glaciated	622	5	270	37	- 13	Saturated	Y	P	P	P	32	28	28	L	>51	Om/Fm	5.25	20
P2.03	07/23/96	63.915425:	-146.795644	679	Glaciated	622	0.0	0.0	56	>-105	Upland	N	W	A	U	>105	13	13	L	>105	Om/Fl	5	
P2.04	07/23/96	63.915488	-146.794799	677	Glaciated	622	0.0	0.0	56	>-111	Upland	N	P	P	A	165	3	3	L	>111	Fl	6	
P2.05	07/23/96	63.915691	-146.794124	682	Glaciated	622	0.0	0.0	30	>-108	Upland	Y	W	P	U	>108	14	14	L	98	Om/Fl/Gm	5.5	
P2.06	07/23/96	63.915772:	-146.793667	683	Glaciated	622	0.0	0.0	50	- 10	Saturated	Y	P	P	P	34	25	25	L	>101	Om/Fl	4.85	20
P2.07	07/23/96	63.916098	-146.792738	683	Lowland	888	0.0	0.0	60	- 17	Saturated	Y	P	P	P	36	64	40	O	>76	Om/Fm	5.65	30
P2.08	07/23/96	63.917096	-146.790433	684	Glaciated	622	0.0	0.0	1	>-31	Saturated	Y	W	P	U	>86	6	6	RE	6	Rfm	7.5	
P2.09	07/24/96	63.918647	-146.78634	668	Lacustrine	854	86	0			Saturated	Y	P	P	A	>132	16	16	R	121	Om/Rfm/Om	6.6	90
P2.10	07/24/96	63.918990:	-146.784064	673	Glaciated	622	0.0	0.0	1	>-28	Upland	N	W	A	A	>28	4	4	R	7	Rfm	5.5	
P2.11	07/24/96	63.920292	-146.781492	668	Lowland	888	2	1	43	- 22	Saturated	Y	P	P	P	44	103	40	O	103	Om	5	30
P3.01	07/26/96	63.764369	-146.257116	986	Upland	888	2	45	1	- 21	Saturated	Y	P	P	P	24	59	40	O	>59	Om	5.3	20
P3.02	07/26/96	63.76716	-146.260674	951	Upland	888	2	315	23	- 18	Saturated	Y	P	P	P	31	39	40	O	>39	Om	5.9	20
P3.03	07/26/96	63.768724	-146.263474	922	Glaciated	621	5	315	50	>-37	Saturated	Y	P	P	P	23	31	31	L	>37	Om/Sm	5.5	
P3.04	07/26/96	63.769069	-146.264245	918	Lowland	484	0.0	0.0	70	- 26	Saturated	Y	P	P	P	32	24	28	L	>44	Om/Fl/Om	5.25	10
P3.05	07/26/96	63.769297:	-146.264711	918	Floodplain	483	0.0	0.0	70	- 23	Saturated	Y	P	P	P	31	7	7	L	>47	Om/Fl	5.8	10
P3.06	07/26/96	63.769491	-146.264877	916	Floodplain	483	0.0	0.0	70	0	Saturated	Y	P	P	P	33	0	15	L	>42	Ol/Fl	6.5	160
P3.07	07/26/96	63.770005:	-146.265062	922	Glaciated	621	5	135	46	- 5	Saturated	Y	P	P	P	>29	6	6	L	>29	Fgm	5.65	20
P3.08	07/26/96	63.770668	-146.265879	933	Glaciated	621	2	135	46	- 18	Saturated	Y	P	P	P	34	37	37	L	>39	Om/Fgm	5.55	1
P3.09	07/26/96	63.771754	-146.267159	953	Glaciated	621	5	135	21	- 23	Saturated	Y	P	P	P	56	23	24	L	>58	Om/Fm/Om	5.9	10
P3.10	07/26/96	63.772989:	-146.269569	991	Glaciated	621	21	31	20	>-36	Upland	Y	W	P	U	>36	18	18	RE	21	Om/Gm	5.5	
P3.11	07/26/96	63.774454	-146.271637	1086	Glaciated	621	8	135	21	>-48	Upland	N	W	A	U	>48	2	2	R	2	Gfm	6	
P4.00A	08/25/96	64.084005	-146.357767	396	Floodplain	702	0.0	0.0	73	nd	Season flooded	ND	nd	nd	U	nd	nd	nd	R	nd	nd		
P4.00B	08/26/96	64.083374	-146.358354	396	Floodplain	912	0.0	0.0	94	nd	Perm flooded	Y	I	nd	U	nd	nd	nd	nd	nd	W		

Alaska Veg Class	Dominant Species	EcoType Group
Broadleaf–Scrub Woodland	betgla-ledgro-potfru-vaculi-salspp.-betpap-popbal	Lowland Low Scrub disturbed
Broadleaf–Scrub Woodland	popbal-salgla-salspp.-potfru/fravir	Riverine Gravelly Dry Broadleaf Forest
Midgrass–Shrub	brosec-calcan-agropy-popbal/fravir	Riverine Gravelly Dry Meadow
Closed Quaking Aspen Forest	poptre/ledgro/mosses	Riverine Moist Broadleaf Forest
Open Low Shrub Birch–Willow Shrub	Betnan-Salgla/Vaculi/Hylspl-Rhyrug-Cetcuc	Lowland Wet Low Scrub
Open Balsam Poplar Forest	popbal-picgla/arcuva-fravir/mosses	Riverine Gravelly Dry Broadleaf Forest
Open Low Shrub Birch–Willow Shrub	Betnan-Salgla/Carbig-Vaculi/Rhyrug-Cladinaspp	Lowland Wet Low Scrub
Open Black Spruce Forest	picmar/alncri/betgla/lichens	Lowland Wet Needleleaf Forest
Open Low Mesic Shrub Birch–Ericaceous Shrub	betgla-poptre-alncri/vacvit-arcrub/stersp.	Lowland Gravelly Moist Low Scrub
Open Low Mesic Shrub Birch–Ericaceous Shrub	betgla-vaculi-poptre/arcrub/stersp.	Lowland Gravelly Moist Low Scrub
Closed Shrub Birch Shrub	betgla/mosses	Lowland Wet Low Scrub
Closed Tall Alder–Willow Shrub	alncri-salpul-betpap/calcan	Upland Moist Low and Tall Scrub
Closed Shrub Birch Shrub	betgla-alncri/vacvit/lichens	Upland Rocky Dry Low Scrub
Open Low Shrub Birch–Willow Shrub	betgla-salgla-vaculi/salret	Upland Moist Low and Tall Scrub
Open Low Shrub Birch–Willow Shrub	betgla-salspp./vaculi/mosses	Upland Moist Low and Tall Scrub
Closed Tall Alder–Willow Shrub	salpul-alncri-salgla/betgla	Lowland Moist Tall Scrub
White Spruce Woodland	Picgla/Betnan-Poptre/Lichens-Hylspl	Lowland Gravelly Needleleaf Forest
Dry Seral Herb	Potmul-Agrpau-Soldec-Elacom-Poagla	Riverine Gravelly Barrens
Open Balsam Poplar Dwarf Tree Scrub	Popbal/Elacom	Riverine Moist Broadleaf Forest
Closed Balsam Poplar–White Spruce Forest	Popbal-Picgla/Pticri	Riverine Moist Mixed Forest
Open Low Silverberry Shrub	Potmul-Elacom-Poagla/Mosses	Riverine Gravelly Low and Tall Scrub
Open White Spruce Forest	Picgla/Hylspl	Riverine Gravelly Needleleaf Forest
Dry Fescue	Potentsp-Agrosubs-Calpur-Carsp	Riverine Gravelly Dry Meadow
Open Low Silverberry Shrub	Popbal-Elacom/Stereo-Racomitrium	Riverine Gravelly Low and Tall Scrub
Closed Balsam Poplar–White Spruce Forest	Picgla-Popbal/Calcan-Equarv/Corcan/Hylspl	Riverine Moist Mixed Forest
White Spruce Woodland	Picgla/Alncri/ Equsyl-Calcan	Upland Moist Low and Tall Scrub
Closed Tall Alder Shrub	Alncri/Calcan	Upland Moist Low and Tall Scrub
Open White Spruce Forest	Picgla/Rosaci-Calcan/Equsil/Hylspl	Upland Wet Needleleaf Forest
Midgrass–Shrub	elyinn-carsup-calpur/artfri-anepat	Upland Rocky Dry Meadow
Open Low Willow Shrub	Salsp-Sallan-Popbal-Elacom/Astrsp-Poasp	Riverine Gravelly Low and Tall Scrub
Open White Spruce Forest	Picgla/Shecan/Drysp/Hylspl	Riverine Gravelly Needleleaf Forest
Dryas–Lichen Dwarf Shrub Tundra	dryoct/crustose lichens	Alpine Rocky Dry Dwarf Scrub
Open White Spruce Forest	picgla/alncri/calcan	Riverine Moist Needleleaf Forest
Dryas Dwarf Shrub Tundra	dryoct-salarc-hiealp-dialap/lichens	Alpine Rocky Dry Dwarf Scrub
Tussock Tundra	erivag-salpul-carbig/mosses	Alpine Wet Tussock Meadow
Open Black Spruce Forest	picmar/ledgro/vacvit-equsyl/mosses	Lowland Wet Needleleaf Forest
Open Black Spruce Forest	picmar/ledgro/vacvit-rubcha/mosses	Lowland Wet Needleleaf Forest
Open Low Mixed Shrub–Sedge Tussock Bog	erivag/rubcha/sphagnum	Lowland Tussock Scrub Bog
Open Low Ericaceous Shrub Bog	rubcha/sphagnum	Lowland Dwarf Scrub Bog
Open Black Spruce Forest	picmar/ledgro/equsyl-erivag/plesch	Lowland Wet Needleleaf Forest
Closed Low Shrub Birch–Ericaceous Shrub	ledgro-betnan/erivag/polytrichum	Lowland Wet Low Scrub
Open Black Spruce Forest	picmar/ledgro/equsyl-erivag/plesch	Lowland Wet Needleleaf Forest
Open Low Mixed Shrub–Sedge Tussock Bog	erivag-leddec-betnan/vacvit/sphagnum	Lowland Tussock Scrub Bog
Open Low Mixed Shrub–Sedge Tussock Bog	erivag-betnan-ledduc-carbig-alncri/plesch	Lowland Tussock Scrub Bog
Open Tall Alder Shrub	alncri/betnan-vaculi-ledduc-carbig/empnig	Upland Moist Low and Tall Scrub
Open Low Shrub Birch–Ericaceous Shrub Bog	carbig-ledduc-betnan-alncri/vacvit/mosses	Lowland Wet Low Scrub
Closed Tall Willow Shrub	salpul/calcan-poapra	Lowland Moist Tall Scrub
Subarctic Lowland Sedge Moist Meadow	carsax	Lowland Moist Meadow
Open Paper Birch Forest	betpap/salbeb/calcan	Lowland Wet Broadleaf Forest
Open Low Mixed Shrub–Sedge Tussock Bog	erivag-leddec-betnan/vacvit/mosses	Lowland Tussock Scrub Bog
Open Low Mixed Shrub–Sedge Tussock Bog	erivag-betnan-leddec-vaculi/sphagnum	Lowland Tussock Scrub Bog
Open Black Spruce Forest	picmar/ledgro/vacvit/mosses	Upland Wet Needleleaf Forest
Subarctic Lowland Sedge Wet Meadow	eriang-carros-carlim	Lacustrine Fen Meadow
Spruce–Paper Birch Woodland	betpap-picmar/vaculi-ledgro-betnan/polytrichum	Upland Rocky Dry Low Scrub
Open Low Mixed Shrub–Sedge Tussock Bog	erivag/vaculi/rubcha/sphagnum	Lowland Tussock Scrub Bog
Tussock Tundra	erivag-carbig-vaculi/empnig	Alpine Wet Tussock Meadow
Open Low Shrub Birch–Ericaceous Shrub Bog	vaculi-betnan-carbig/sphagnum	Alpine Wet Low Scrub
Open Low Shrub Birch–Willow Shrub	salpul-betnan/carbig/sphagnum	Alpine Wet Low Scrub
Sedge–Birch Tundra	caraqu-vaculi-eriang-ledduc/sphagnum	Alpine Wet Meadow
Closed Shrub Birch Shrub	betnan/eriang/feathermoss	Alpine Wet Low Scrub
Wet Sedge Meadow Tundra	eriang-arcful-caraqu-carros	Alpine Wet Meadow
Closed Shrub Birch Shrub	betnan-salpul/mosses	Alpine Wet Low Scrub
Tussock Tundra	erivag-vaculi-betnan/mosses	Alpine Wet Tussock Meadow
Sedge–Birch Tundra	carbig-vaculi-betnan/sphag-plesch	Alpine Wet Low Scrub
Open Tall Alder Shrub	alncri/salpul-betnan-vaculi/plesch	Alpine Rocky Moist Low Scrub
Open Low Mesic Shrub Birch–Ericaceous Shrub	betnan-vaculi-ledduc-salpul/plesch	Alpine Rocky Moist Low Scrub
Barren (<5% vegetated)	barren	Riverine Gravelly Barrens
Water (<5% vegetated)	barren	Upper Perennial River

Table B1 *(cont'd)*. Data file listing environmental characteristics of ground-reference plots, Fort Greely, Alaska, 1999.

Plot name	Date	Latitude (NAD27)	Longitude (NAD27)	Elevation (m)	Physiography	Geomorph	Slope (deg)	Aspect (deg)	Surface form	Water depth (cm)	NWI-Water Regim	Sat 30 cm (Y,N,ND)	Drainage general	Hydr soil (present,absent)	Permafrost (present,absent, unknown)	Thaw depth (cm)	SurfOrgDepth (cm)	CumOrg40 (cm)	DomMinTe (0–50 cm)	GravDep (cm)	Lithosequence	pH	EC
P4.01	08/25/96	64.084625	-146.357003	397	Floodplain	711	0.0	0.0	71	>-50	Season flooded	N	E	A	A	>50	0	0	R	0	Gfm	9.1	210
P4.02	08/25/96	64.08551	-146.356442	397	Floodplain	711	0.0	0.0	71	>-40	Upland	N	E	A	A	>40	0	0	S	30	Fl/Gm		
P4.03	08/25/96	64.086130:	-146.35554	397	Floodplain	712	0.0	0.0	71	>-100	Upland	N	W	A	A	>100	8	8	L	100	Ol/Fl/Sm/Gm		
P4.04	08/25/96	64.086703	-146.355289	396	Floodplain	712	0.0	0.0	71	>-80	Upland	N	W	A	A	>182	8	9	L	182	Om/Fl/Ol		
P4.05	08/26/96	64.087818:	-146.354115	396	Floodplain	712	0.0	0.0	71	>-65	Upland	N	W	A	A	>65	8	18	L	51	Om/Fl/Gfm		
P4.06	08/26/96	64.089241:	-146.353572	397	Lowland	452	0.0	0.0	71	- 19	Saturated	Y	P	P	P	33	32	32	L	>33	Om/Fm	7.4	50
P4.07	08/26/96	64.090618	-146.352386	394	Lowland	452	0.0	0.0	71	>-83	Upland	N	W	P	A	>96	7	15	L	96	Om/Ol/Fl	6.5	120
P4.08	08/26/96	64.091578	-146.352619	394	Lowland	452	0.0	0.0	70	>-69	Upland	N	W	A	A	>280	13	13	L	280	Om/Fl	7.1	240
P4.09A	08/26/96	64.091816	-146.351377	398	Glaciated	621	5	270	32	>-63	Upland	N	W	A	A	>63	15	15	S	>63	Om/Fl	6.7	80
P4.09B	08/26/96	64.092105:	-146.350423	403	Glaciated	621	15	270	17	>-52	Upland	N	P	P	P	52	21	21	L	>52	Om/Fl		
P4.10	08/26/96	64.092257	-146.349106	416	Glaciated	621	2	270	17	>-41	Saturated	Y	W	P	P	77	20	20	R	30	Om/Fgm/Gfm	5.6	60
P4.11	08/26/96	64.092697	-146.347884	419	Lowland	371	0.0	0.0	61	- 22	Saturated	Y	P	P	P	33	17	17	L	>33	Om/Fomt	7.1	30
P5.00	08/28/96	63.839175:	-146.595508	1330	Upland	335	34	180	26	>-50	Upland	N	E	A	U	>50	0	0	RE	0	Rm	5.8	180
P5.02	08/28/96	63.839372:	-146.593135	1297	Upland	335	30	1	26	>-40	Upland	N	E	A	P	>60	0	0	RE	0	Rm	5.6	48
P5.03	08/29/96	63.83945	-146.587763	1144	Upland	335	34	130	26	>-50	Upland	N	E	A	A	>60	0	0	RE	0	Rm	5.3	156
P5.04	08/29/96	63.839483	-146.583392	1027	Upland	335	30	135	26	>-40	Upland	N	E	A	U	>40	0	0	RE	0	Rm	5.1	310
P5.05	08/29/96	63.839825	-146.582598	1005	Upland	335	37	140	21	>-35	Upland	N	E	A	U	>35	0	0	RE	0	Rm	5.8	220
P5.06	08/29/96	63.839778	-146.581121	984	Upland	335	35	135	16	>-35	Upland	N	E	A	U	>35	3	3	RE	3	Rm	4.4	75
P5.08	08/29/96	63.839989	-146.578209	907	Lowland	520	17	80	50	nd	Saturated	N	P	A	P	36	17	>26	L	>36	Om	4.1	164
P5.09	08/29/96	63.840109:	-146.575121	877	Floodplain	506	10	110	22	>-50	Upland	N	E	A	U	>50	11	16	RE	20	Om/Ol/Rm	4.1	122
P5.10	08/29/96	63.840145	-146.571652	860	Floodplain	483	3	30	71	>-45	Upland	N	W	A	U	>45	4	4	RE	21	Ol/Gm	3.3	160
P5.10B	08/29/96	63.840018	-146.570116	861	River	911	95	30			Perm flooded	Y	I	nd	U	nd	nd	nd	RE	nd	W	7.3	352
P5.11	08/29/96	63.839709	-146.569305	871	Lowland	520	11	325	50	- 40	Saturated	Y	P	P	P	50	20	20	L	42	Om/Fomt/Gf	3.8	189
P5.12	08/29/96	63.838772:	-146.567123	917	Upland	335	30	315	23	>-35	Upland	N	W	P	P	>35	9	9	R	9	Rfm	4.7	120
P5.13	08/25/96	63.836973	-146.564895	951	Upland	335	30	315	23	>-50	Upland	N	P	P	P	>50	20	20	L	36	Om/Fgm/Gm	5.4	90
P6.01	08/31/96	63.86157	-145.810764	573	Glaciated	622	2	270	16	>-48	Upland	N	W	A	U	>48	4	13	L	>48	Fomt	5	20
P6.02	08/31/96	63.861224	-145.808855	577	Glaciated	372	2	90	17	>-40	Upland	N	W	A	A	>40	7	7	L	30	Fgm/Gfm	5.2	10
P6.04	08/31/96	63.861037	-145.807727	566	Glaciated	622	0.0	0.0	56	- 15	Saturated	Y	P	P	A	>35	2	2	R	8	Fgm/Gfm	5.1	30
P6.05	08/31/96	63.860777	-145.805984	566	Lacustrine	750	0.0	0.0	86	8	Perm flooded	Y	P	P	U	>70	7	7	L	103	Fom/Gfm	5.7	30
P6.07	08/31/96	63.860702	-145.804973	568	Glaciated	622	5	270	21	>-40	Upland	N	W	A	U	>40	9	9	R	14	Om/Rfm	4.5	20
P6.08	09/01/96	63.86058	-145.804087	571	Glaciated	622	10	180	21	>-40	Upland	N	E	A	A	>40	1	1	RE	4	Gm	5.7	10
P6.09	09/01/96	63.860491	-145.802643	564	Lacustrine	947	86	50			Perm flooded	Y	I	nd	U	nd	nd	nd	nd	nd	W		
P6.10	09/01/96	63.860318	-145.80159	565	Glaciated	622	7	270	50	>-40	Saturated	N	P	P	U	>40	3	3	R	8	Fgm/Gfm	5.1	10
P6.11	09/01/96	63.86013	-145.799992	596	Glaciated	622	10	225	21	>-50	Upland	N	E	A	A	>50	2	2	RE	4	Gm	5.1	10
P6.12	09/01/96	63.858814	-145.788155	602	Glaciated	621	0.0	0.0	1	>-40	Upland	N	E	A	A	>40	0	0	RE	0	Gm	5.2	10
P6.13	09/01/96	63.857514	-145.787164	599	Glaciated	621	0.0	0.0	56	5	Semi-perm flooded	Y	P	P	A	>180	23	23	R	23	Om/Gfm	5.8	45
P6.15	09/01/96	63.856187:	-145.786543	602	Glaciated	621	2	0.0	28	>-65	Upland	N	W	A	A	>110	7	7	R	11	Fom/Gfm	4.8	30
P6.16	09/01/96	63.855229	-145.786348	603	Glaciated	621	70	- 5			Saturated	Y	P	P	P	43	35	35	L	>43	Om/Fgm	5.6	37
P6.17	09/01/96	63.854348	-145.785741	608	Glaciated	621	2	0.0	48	- 15	Saturated	Y	P	P	P	55	14	14	R	29	Om/Fom/Gfm	5.9	40
P6.18	09/01/96	63.853049	-145.784207	621	Glaciated	621	2	0.0	28	>-50	Upland	N	W	A	A	>50	3	3	RE	14	Fm/Gm	6.2	40
P6.19	09/01/96	63.852181	-145.784023	625	Glaciated	621	0.0	0.0	28	>-50	Upland	N	E	A	A	>50	1	1	RE	2	Gm	6.4	10
V20.12a	08/03/98	63.7873	-145.79664:	844	Upland	12	330	13	>-20		Upland	nd	P	nd	P	>20	20	20	R	20	Om/Gfm	6.81	260
V50.01	08/04/98	63.841065	-146.668757	1343	Upland	11	0.0	0.0	1	>-28	Upland	N	W	A	U	>30	5	5	R	15	Gfm/R	4.79	15.4
V50.02	08/04/98	63.838964	-146.666841	1457	Upland	11	30	180	11	>-20	Upland	nd	E	A	U	>30	0	0	RE	0	Gfm/R	7.59	429
V50.03	08/05/98	63.8413	-146.659883	1241	Lowland	520	5	45	50	>-33	Saturated	nd	P	P	P	>33	2	5	L	>40	Fom/Gfm	6.21	100
V50.04	08/05/98	63.840255	-146.658239	1229	Lowland	520	10	360	38	>-22	Upland	nd	W	nd	P	>22	7	7	R	15	Om/Gfm	4.75	42
V50.05	08/05/98	63.8363	-146.6621	1345	Upland	12	0.0	360	28	>-15	Upland	nd	E	nd	U	>15	1	1	R	20	Gfm/R	4.87	4
V50.06	08/05/98	63.833955:	-146.657148	1330	Lowland	520	10	270	32		Saturated	Y	P	P	P	>20	0	0	R	25	Gfm/R	6.2	266
V50.07	08/05/98	63.832983	-146.6493	1418	Upland	11	2	180	1	nd	Upland	nd	E	A	U	nd	0	0	RE	0	R		

Alaska Veg Class	Dominant Species	EcoType Group
Dryas Dwarf Shrub Tundra	drydru	Riverine Gravelly Dry Dwarf Scrub
Open Balsam Poplar Forest	popbal/drydru-oxycam	Riverine Gravelly Dry Broadleaf Forest
Closed Balsam Poplar–White Spruce Forest	popbal-picgla/alten	Riverine Moist Mixed Forest
Open White Spruce Forest	picgla/alncri/calcan-equarv/rhytri	Riverine Moist Needleleaf Forest
Open Spruce–Paper Birch Forest	betpap-picgla/alncri/rosaci/corcan.rhytri	Riverine Moist Mixed Forest
Open Black Spruce Forest	picmar/ledgro/vacvit-rubcha/hylspl-sphagnum	Lowland Wet Needleleaf Forest
Closed Paper Birch Forest	betpap-picgla/rosci/equarv-calcan	Lowland Wet Broadleaf Forest
Subarctic Lowland Sedge Moist Meadow	carsax	Lowland Moist Meadow
Open White Spruce Forest	picgla/alncri/calcan-rosaci/hylspl	Lowland Wet Needleleaf Forest
Open White Spruce Forest	picgla/alncri/equarv-calcan/hyspl	Upland Wet Needleleaf Forest
Open Black Spruce Forest	picmar/ledgro/vacvit/hylspl-sphagnum	Upland Wet Needleleaf Forest
Open Black Spruce Forest	picmar/ledgro/rubcha-vacvit/sphagnum	Lowland Wet Needleleaf Forest
Partially Vegetated (>5,<30% cover)	dryoct	Alpine Rocky Dry Barrens
Cassiope Dwarf Shrub Tundra	castet-dryoct/vaculi-salarc/fesalt/lichc	Alpine Rocky Dry Dwarf Scrub
Open Low Shrub Birch–Willow Shrub	salgla-betnan-vaculi-salpul-potfru/fesalt/epiang/rhyrug	Alpine Rocky Moist Low Scrub
Open Balsam Poplar Forest	popbal/betnan-salgla/fesalt	Alpine Rocky Moist Low Scrub
Barren (<5% vegetated)	artarc-saxtri-fessp.-arnsp./lichens	Alpine Rocky Dry Barrens
Closed Tall Alder Shrub	alncri/calcan-betnan	Alpine Rocky Moist Low Scrub
Open Black Spruce Dwarf Tree Scrub	picmar/betnan-carbig/plesch-sphag	Lowland Wet Needleleaf Forest
Closed Tall Alder Shrub	alncri/calcan-spibea/feathermoss	Riverine Gravelly Low and Tall Scrub
Open Tall Alder Shrub	alncri/vaculi/hylspl-plesch	Riverine Gravelly Low and Tall Scrub
Water (<5% vegetated)	barren	Upper Perennial River
Open Low Shrub Birch–Ericaceous Shrub Bog	betnan-vaculi-salpul-alncri/plesch-hylspl	Lowland Wet Low Scrub
Open Tall Alder Shrub	alncri/vaculi/empnig-vacvit	Alpine Rocky Moist Low Scrub
Open Tall Alder Shrub	alncri/betnan-leddec/vacvit-empnig/hylspl	Alpine Wet Low Scrub
Spruce–Quaking Aspen Woodland	picgla-poptre/alncri-salbeb/hylspl	Upland Moist Low and Tall Scrub
Open Quaking Aspen Dwarf Tree Scrub	poptre/vacvit/hylspl	Upland Rocky Dry Broadleaf Forest
Bluejoint Meadow	calcan-arclat-eriang	Lowland Moist Meadow
Subarctic Lowland Sedge Wet Meadow	carros/drep	Lacustrine Fen Meadow
Open Black Spruce Forest	picmar/vaculi-betnan/vacvit/hylspl	Upland Moist Needleleaf Forest
Open Quaking Aspen Dwarf Tree Scrub	poptre/arcuva-vacvit/stereocaulon	Upland Rocky Dry Broadleaf Forest
Pondlily	potalp-nuppol-isomur	Ponds and Lakes Potaalpi-Nuphpoly
Closed Low Shrub Birch–Ericaceous Shrub	betnan-ledgro-vaculi/vacvit	Lowland Wet Low Scrub
Open Quaking Aspen Dwarf Tree Scrub	poptre/arcalp/lichens	Upland Rocky Dry Low Scrub
Bearberry Dwarf Shrub Tundra	arcalp-betnan-dryoct/lichens	Upland Rocky Dry Low Scrub
Subarctic Lowland Sedge Wet Meadow	eriang-caraqu-calcan	Lowland Fen Meadow
Closed Shrub Birch Shrub	betnan-ledgro-vaculi/vacvit/hylspl	Upland Moist Low and Tall Scrub
Black Spruce Woodland	picmar/betnan-salpul-vaculi-ledduc/erivag	Lowland Wet Low Scrub
Closed Black Spruce Forest	picmar/vaculi-calcan/vacvit/hylspl	Lowland Gravelly Needleleaf Forest
Open Black Spruce Forest	picmar/betnan/vacvit/hylspl	Upland Moist Needleleaf Forest
Open Low Mesic Shrub Birch–Ericaceous Shrub	betnan/arcalp-vacvit/stereocaulon-rhyrug	Upland Rocky Dry Low Scrub
Open Low Mesic Shrub Birch–Ericaceous Shrub	alncri/betnan-vaculi-carspp./dryoct	Alpine Rocky Moist Low Scrub
Dryas–Sedge Dwarf Shrub Tundra	dryoct-salret-castet-fesalt	Alpine Rocky Dry Dwarf Scrub
Partially Vegetated (>5,<30% cover)	saxtri-epilan-pritsc-delgla	Alpine Rocky Dry Barrens
Bluejoint–Herb	calcan-deldel-epiang-equarv	Alpine Wet Meadow
Ericaceous Dwarf Scrub	castet-salala-vaculi-dryoct-vacvit	Alpine Rocky Dry Dwarf Scrub
Dryas–Sedge Dwarf Shrub Tundra	dryoct-artalp-salart	Alpine Rocky Dry Dwarf Scrub
Wet Sedge Meadow Tundra	eriang-arclat-carmic-saxhir	Alpine Wet Meadow
Partially Vegetated (>5,<30% cover)	dryoct-salpol-oxynig-crust lichens	Alpine Rocky Dry Barrens

Table B2. Data file listing of environmental characteristics of map verification plots, Fort Greely, central Alaska, 1999.

PLOTNAME	Date	Latitude (NAD27)	Longitude (NAD27)	Vegetation Stucture	Dominant Species	Ecotype Group	FlorClass
V10.03a	08/17/98	64.235266	-146.717194	Closed mixed forest	Popbal(20), Picgla(30), Betpap(10), Poptre(5), Shecan(20), Hedmac,Linbor,Fravir(2),Salbeb(5),Vacvi	Lowland Gravelly Dry Mixed Forest	Piceglau–Populbals–Shepcana
V10.07	08/17/98	64.236861	-146.704821	Open Broadleaf forest	Betpap(40),Alncri(70),Calcan(60)Rosacr(10)Equsyl(10)Vibedu(5)	Upland Moist Broadleaf Forest	Betupapy–Calacana
V10.08	08/17/98	64.233911	-146.69699	Closed Broadleaf forest	Betpap(70),Alncri(60),Calcan(20),	Upland Moist Broadleaf Forest	Betupapy–Calacana
V10.09	08/17/98	64.232733	-146.694644	Closed Needleleaf forest	Picgla(70),Betpap(10),Hylspl(90),Geoliv(5),Rosaci(3),Alncri(1),Linbor(5),Merpau(1)	Upland Moist Needleleaf Forest	Piceglau–Alnucris
V10.10	08/17/98	64.231126	-146.694241	Closed Broadleaf forest	Poptre(60),Picgla(20),Shecan,Rosaci,Galbor?,Agrsub?Umbbel,Linbor,Arcuva	Upland Rocky Dry Broadleaf Forest	Poputrem–Arctuva-
V10.10b	08/17/98	64.231619	-146.694244	Closed mixed forest	Poptre(40),Picgla(30),Shecan,Geoliv,Epiang,Umbel,Linbor,Acodel	Upland Moist Mixed Forest	Poputrem–Arctuva-
V10.11	08/17/98	64.231134	-146.686522	Closed Broadleaf forest	Betpap(80),Picgla(5),Alncri,Vibedu,Rosaci,Calcan,Stel,,(RockDep=35)	Upland Moist Broadleaf Forest	Betupapy–Piceglau–Rosaacic
V10.12a	08/17/98	64.23173	-146.684	Closed Broadleaf forest	Betpap(60),Picgla(5),Alncri,Vibedu,Rosaci,Calcan,Linbor	Upland Moist Broadleaf Forest	Betupapy–Piceglau–Rosaacic
V10.13	08/17/98	64.230057	-146.677938	Closed Broadleaf forest	Betpap(60)-Picgla(10),Alncri,Vibedu,Calcan,Linbor,Hylspl(1%)	Upland Moist Broadleaf Forest	Betupapy–Piceglau–Rosaacic
V11.08	08/16/98	64.109211	-146.448309	Woodland Dwarf Tree Scrub	Picmar(10),Betnan,Ledpal,Vaculi,Empnig,Carbig,Erivag, Sphag	Lowland Wet Needleleaf Forest	Picemari–Ledugroe
V11.09	08/16/98	64.10793	-146.44543	Woodland Dwarf Tree Scrub	Picmar(10),Erivag(20),Ledpal,Betnan,Vaculi,Rubcha,Sphag(10) (no Empnig)	Lowland Tussock Scrub Bog	Eriovagi–Picemari
V11.11	08/16/98	64.110455	-146.441272	Closed low scrub	Erivag,Betnan,Ledpal,Vaculi, Vacvit,Picmar(3%), Sphag,(no Empnig)	Lowland Tussock Scrub Bog	Eriovagi–Picemari
V11.12	08/16/98	64.112149	-146.436708	Closed low scrub	Alncri(20), Betnan(40),Ledpal(40),Vaculi,Erivag(15),Carbig,Sphag, Picmar(3)	Lowland Wet Low Scrub	Betunana–Vacculig
V11.13	08/16/98	64.112268	-146.433316	Woodland Dwarf Tree Scrub	Betnan(20),Alncri(10),Ledpal(30),Vaculi(15), Erivag(15),Picmar(10)	Lowland Wet Low Scrub	Betunana–Vacculig
V11.13a	08/17/98	64.109871	-146.431185	Closed mixed forest	Betpap(40),Picmar(25),Picgla(5),Calcan(60),Equsyl(20)	Lowland Wet Mixed Forest	Betupapy–Picemari–Ledugroe
V11.14	08/16/98	64.110423	-146.429091	Open Dwarf Tree Scrub	Picmar(40),Ledpal,Ledgro,	Lowland Wet Needleleaf Forest	Picemari–Ledugroe
V11.14a	08/18/98	64.111493	-146.422531	Closed mixed forest	Betpap(40),Picmar(30),Calcan(30),Rosaci(10),Equsyl(10),salbeb(10)	Lowland Wet Mixed Forest	Betupapy–Picemari–Ledugroe
V11.15	08/16/98	64.109776	-146.424729	Closed Needleleaf forest	Picmar(65),Ledgro(5), Vacvit(10),Geoliv(10),Hylspl(90)	Lowland Wet Needleleaf Forest	Picemari–Ledugroe
V11.16	08/16/98	64.109112	-146.421615	Open Needleleaf forest	Picmar(30),Ledgro(20),Betnan(20),Vaculi,Vacvit,Hylspl(80),Equsyl(5)	Lowland Wet Needleleaf Forest	Picemari–Ledugroe
V11.16b	08/20/98	64.10407	-146.419	Open Dwarf Tree Scrub	Picmar(30)Ledgro,Vaculi,Erivag(3)	Lowland Wet Needleleaf Forest	Picemari–Ledugroe
V11.17	08/16/98	64.107144	-146.415222	Open Needleleaf forest	Piicmar(55)Ledgro(20),Ledpal(5), Vaculi,Vacvit,Equsyl(3),Hylspl(80)	Lowland Wet Needleleaf Forest	Picemari–Ledugroe
V11.18	08/16/98	64.106967	-146.410828	Closed mixed forest	Betpap(40),Picmar(40),Ledgro(10),Rosaci(5),Calcan(5),Hylspl(80)	Lowland Wet Mixed Forest	Betupapy–Picemari–Ledugroe
V11.19	08/16/98	64.107778	-146.409928	Closed Broadleaf forest	Betpap(80),Picgla(10), Rosaci,Equisyl(20),Calcan(10),Linbor	Upland Moist Broadleaf Forest	Betupapy–Calacana
V17.01	08/15/98	63.98229	-146.091882	Open White Spruce-Paper Birch Forest	Piccgla(30),Betpap(25),Rosaaci(25),Alncri(15)Calsp(10)	Lowland Wet Mixed Forest	Betupapy–Piceglau–Rosaacic
V17.02	08/15/98	63.983068	-146.088308	Closed White spruce-Paper Birch Forest	Picgla(50),Betpap(15),Picmar(10),Alncri(25)*,Vacvit(50)*	Lowland Wet Needleleaf Forest	Piceglau–Alnucris
V17.03	08/15/98	63.984981	-146.091123	Mixed Shrub Tussock	Alncri(40)*,Salspp(25)*,Erivag(45),Betnan(10) burned	Lowland Tussock Scrub Bog	Eriovagi–Empenigr
V17.05	08/15/98	63.988131	-146.089582	Black spruce dwarf Woodland	Erivag(35),Picmar(15),Betnan(30),Alncri(30)Ledgro(20)	Lowland Tussock Scrub Bog	Eriovagi–Picemari
V17.06	08/15/98	63.990396	-146.087973	Mixed Shrub Tussock	Erivag(35),Betnan(30,Alncri(20)Arctagros(10),Salap(10)	Lowland Tussock Scrub Bog	Eriovagi–Empenigr
V17.07	08/15/98	63.991741	-146.080829	Closed Mixed PaperBirch-Spruce	Betpap(75),Picgla-understory(25),Hylspl(50),Pyrspp(3),Rosaci(20),Cal(20)	Upland Moist Broadleaf Forest	Betupapy–Piceglau–Rosaacic
V17.08	08/15/98	63.990192	-146.075699	Closed Mixed White Spruce-Paper Birch	Betpap(40),Picgla(20),Salbeb(10),Hylspl(40),Empnig(tr)Led(tr)	Lowland Wet Mixed Forest	Betupapy–Piceglau–Rosaacic
V18.01	08/15/98	64.017239	-146.208173	Closed Broadleaf forest	Betpap(80), Picgla(30,understory)Equsyl,Hylspl, Hylspl, Corcan, Rosaci	Upland Moist Broadleaf Forest	Betupapy–Piceglau–Rosaacic
V18.02	08/15/98	64.019549	-146.217841	Open Dwarf Tree Scrub	Picmar(30), Ledgro,Ledpal,Rubcha,Vaculi,Sphag	Lowland Wet Needleleaf Forest	Picemari–Ledugroe
V18.03	08/15/98	64.018937	-146.220931	Open Dwarf Tree Scrub	Picmar(50)Ledgro,Rubcha,Sphag,Petfri	Lowland Wet Needleleaf Forest	Picemari–Ledugroe
V18.04	08/15/98	64.017357	-146.221941	Open mixed forest	Picmar(40),Betpap(10),Calcan,Ledgro,Equsyl,Petfri	Lowland Wet Mixed Forest	Picemari–Ledugroe
V18.07	08/15/98	64.011976	-146.227349	Closed Broadleaf forest	Betpap(80),Picgla(30,understory), Rosaci,Vibedu,Linbor,Hylspl(5)	Upland Moist Broadleaf Forest	Betupapy–Piceglau–Rosaacic
V18.08	08/15/98	64.012626	-146.229656	Closed Dwarf Tree	Picmar(70%3-4m),Calcan,Epilat,Poljun,Ledgro(tr)	Lowland Wet Needleleaf Forest	Picemari–Ledugroe
V18.09	08/15/98	64.012406	-146.232048	Open Dwarf Tree Scrub	Picmar(30),Ledpal,Ledgro,Vaculi, Erivag,Carbig,Rubcha	Lowland Wet Needleleaf Forest	Picemari–Ledugroe
V18.10	08/15/98	64.01197	-146.235347	Woodland Dwarf Tree Scrub	Erivag(20), Picmar(15), Ledpal, Ledgro, Vaculi, Betnan, Carbig, Sphag	Lowland Tussock Scrub Bog	Eriovagi–Picemari
V18.16	08/15/98	64.01135	-146.249	Closed Broadleaf forest	Betpap(70),Picgla(25),Equarv,Calcan,Merpan,Rosaci	Riverine Moist Mixed Forest	Betupapy–Piceglau–Rosaacic
V20.05b	08/20/98	63.78702	-145.788	Dryas Lichen Tundra	Arcalp(15),Dryoct(15), Ster(20)Vaculi(10), Rhyrug(5),Hieralp (2), Artarc(2), Salret(5)	Alpine Rocky Dry Dwarf Scrub	Dryaocto–Lichens
V20.05c	08/20/98	63.784261	-145.787563	Closed Low Alder	No Real plot typed from above,pinpricked	Alpine Rocky Moist and Wet Low and Tall Sc	nd
V20.08b	08/20/98	63.78192	-145.789	Dryas Tundra	Dryoct(20),Arcalp(5), Salarc(2),Dia(tr)Carbig(2), LichCrustose(10), Minu(tr)Saxpun(tr)	Alpine Rocky Dry Dwarf Scrub	Dryaocto–Lichens
V20.09	08/20/98	63.783128	-145.79005	PV (Dryas Tundra)	Dryoct(8), Salarc(1)Carbig(3)Minu(tr)Saxpun(tr)Arcalp(1)	Alpine Rocky Dry Barrens	Dryaocto–Lichens
V20.15up	08/20/98	63.780063	-145.790896	Open Low Alder-Betula	Alncri(15), Betnan(10), salgla(5),Vaculi(25),Dryoct(5),Salarc(2), mosssp(20),StereoLichens(10)	Alpine Rocky Moist and Wet Low and Tall Sc	Alnucris–Empenigr
V20.15low	08/20/98	63.778944	-145.790798	Closed Tall Alder	Closed Tall (or Borderline Low) Alder w Scattered white spruce in gully-observed from above	Alpine Rocky Moist and Wet Low and Tall Sc	nd
V22.06	08/26/98	63.943172	-145.519939	Open Aspen	Salgla(15),Poptre(35),Arcuva(5),Litter(85),Calcan(10,Cerato(10),Epiang(10),Rosa(5),Bare ground (10	Upland Rocky Dry Broadleaf Forest	Poputrem–Arctuva-
V22.06b	08/26/98	63.944656	-145.516613	Closed Shrub Birch, Ericaceous	Betnan(75),Salplan(10),Chama(5),Arctalp(2),Vacculig(15),Ledugroe(5),Calcan(20)	Lowland Wet Low Scrub	Betunana–Vacculig
V22.12	08/26/98	63.947704	-145.509477	Closed Aspen	Poptrem(65), Salbeb(5),Betpap(5), Lupin(1),Vavi(2), Downed trees(15) Polyt(10), Cascan(tr)	Upland Rocky Dry Broadleaf Forest	Poputrem–Arctuva-
V22.13	08/26/98	63.949163	-145.511444	Open Paper Birch	Betpap(55)Salbeb(15)Salarb(10)Salgla(10)Rosaci(5),Calcan(10), Picmar(5)Litter(90)	Upland Rocky Dry Broadleaf Forest	Betupapy–Calacana
V22.14	08/26/98	63.949036	-145.516603	Closed Shrub Birch--Ericaceous	Betnan(75), Vaculi(15), Erivag(5),Arclat(5),Salpla(2),Carbig(5),	Lowland Gravelly Moist Low Scrub	Betunana–Vacculig
V22.16	08/26/98	63.94666	-145.519836	Open Aspen	Salsp(20),Poptre(25),Ceratodon(10),Calamagr(15),Ledgro(10),Vaculi(5),Arcuva(2),Epiang(15), bare s	Upland Moist Low and Tall Scrub disturbed	Poputrem–Arctuva-
V25.21	08/17/98	64.07282	-146.564	Closed Moist Mixed Foerst	Poptrem(40), Picmar(30),Salspp(20),Ledgro(10),Polytri(10)	Upland Rocky Dry Broadleaf Forest	Poputrem–Arctuva-
V25.22	08/17/98	64.07005	-146.567	Open Black Spruce Forest/Closed Mixed Eri	Ledgro(40),Equissyl(10), Polytrich(35),Vacvit(20), Betnan(25),Picmar sapling((25,)	Lowland Wet Low Scrub	Picemari–Ledugroe
V25.23	08/17/98	64.0675	-146.577	Alder/ Ericaceous Shrub	Alncri(20), Betnan(10),Leddec(10), Empnig(5), Sphag(60), Erivag(10), Pleur(5), Rubcham(75)	Lowland Wet Low Scrub	Alnucris–Empenigr
V25.25	08/17/98	64.06848	-146.59	Wet Graminoid	Eriang(40),Carrost(5), Betnan(2),Equflu(5), Vaculi(1), Sphag(50),Water(25)	Riverine Wet Meadow	Erioangu–Vacculig
V25.26	08/17/98	64.06925	-146.597	Mixed Shrub Tussock	Erivag(55),Ledspp(30),Betnan(15),Vaculi(10), Picmar seedl(tr), Sphag(20)Alncri(15)	Lowland Tussock Scrub Bog	Eriovagi–Picemari
V25.27	08/17/98	64.07223	-146.608	Mixed Shrub Tussock	Erivag(60), Alncri(10), Betnan(15),Vaculi(10)Leddec(10),Vacvit(5),Empnig(3),Sphag(15)	Lowland Tussock Scrub Bog	Eriovagi–Empenigr
V25.28	08/17/98	64.07477	-146.615	Open White Spruce Paper Birch Forest	Picgla(20), Betpap(20), Alncri(20),Calcan(15),Equarv(5), Litter(80)	Riverine Moist Mixed Forest	Betupapy–Piceglau–Rosaacic
V28.01	08/16/98	64.111981	-146.397628	Open Black Spruce Forest/Closed Mixed Eri	Picmar(25),Ledum(55),Vaculi(15), Vacvit(20), Alncri(5), Empnig(10), Sphagnum+Feathermoss(85)	Lowland Wet Needleleaf Forest	Picemari–Ledugroe
V28.01b	08/16/98	64.10167	-146.396	Closed Tall Alder	alnten (80) Salala	Riverine Gravelly Low and Tall Scrub	Alnucris–Calacana
V28.02	08/16/98	64.111897	-146.391958	Open White Spruce Forest	Picgla(40), Feathermoss (95), Pyrgra(50, Vacvit(20), Rosaci(10)	Riverine Moist Needleleaf Forest	Picemari–Piceglau–Vaccviti
V28.03	08/16/98	64.110558	-146.389912	Open White Spruce Forest	Picgla(55), Popbal(5), Shecan(15), Salspp(5), Peltig+Lichens(10), Feathermoss(40), Geoliv(5)	Riverine Gravelly Needleleaf Forest	Piceglau–Populbals–Shepcana
V28.04a	08/16/98	64.11083	-146.388	Open Balsam Poplar Forest	Popbal(45),Astrag(10), Shecan(5),Drydrum(20), Stereocaulon(10), Fragaria(2)	Riverine Moist Broadleaf Forest	Popubals–Fragvirg
V28.06	08/16/98	64.105913	-146.386823	Dry Agropyron Graminoid Meadow	Agropyron(25)*,Drydrum(5),Fraviv(2),Stellaria(5),Oxycam(15),Astrag(5), popbal(tr0	Riverine Gravelly Dry Meadow	Agropyro–Festuca
V28.07	08/16/98	64.104054	-146.383992	Open Balsam Poplar Forest	Popbal dwarf(55), Hedmac(5), Drydru(40), Ast(5), Oxysp(5)	Riverine Moist Broadleaf Forest	Popubals–Fragvirg
V28.09	08/16/98	64.103575	-146.380218	Open White Spruce Forest	Picgla(30), Hylspl(65), Rhytri(25), Ledum(30)Vacvit(20)	Lowland Wet Needleleaf Forest	Piceglau–Alnucris
V30.09	08/28/98	64.011533	-145.725378	Seral Forb-BP Sapling	Popbal(15), Trifolium(25), Phleum(10), Frag(10), Brompum(5), Oxycam(5), Bareground(3)	Upland Moist Low and Tall Scrub	Popubals–Fragvirg
V30.13	08/28/98	64.02315	-145.722	Open Balsam Poplar/ PV	Popbal saplings(2), Hedmac(5), soliddecum(1), Astsib(4)*Oxycam(1), Potmul(1), Elymnov(1)	Riverine Gravelly Barrens	Barrens

Table B2 *(cont'd)*.

V30.14	08/28/98	64.02355	-145.726	Barren	Artemalaska?(tr), Eleag(tr), Hedmac(1), Crepis(tr),Elymus*(tr), Oxycam(tr)BP(tr)	Riverine Gravelly Barrens	Barrens
V33.01	08/18/98	63.800024	-146.284109	Open Dwarf Tree Scrub	Picmar(40), Betnan(20), Salpul(5), Erivag(5), Vaculi(10), Ledpal(15)	Lowland Wet Needleleaf Forest	Picemari–Ledugroe
V33.02	08/18/98	63.79566	-146.286561	Closed low scrub	Betnan(15), Vaculi(30), Ledpal(20), Carbig(10), Erivag(5), Empnig(10)	Alpine Wet Low Scrub	Betunana–Vacculig
V33.04	08/18/98	63.79339	-146.291738	Open Low Scrub	Betnan(30), Vaculi(20), Ledpal (20), Carbig(15), Empnig(5), Salpul(3), Mosses 90	Alpine Wet Low Scrub	Betunana–Vacculig
V33.05	08/18/98	63.792848	-146.294908	Ericaceous Dwarf Scrub	Vaculi(30), Ledpal(10), Empnig(20), Carbig(10), Sphag (60), Betnan(5)	Alpine Wet Low Scrub	Betunana–Vacculig
V33.07	08/18/98	63.790731	-146.293348	Closed low scrub	Betnan(60), Alncri(10), Vaculi(20), Ledpal(20), Carbig(10), Salpla(5), Sphag (20)	Alpine Wet Low Scrub	Betunana–Vacculig
V33.08	08/18/98	63.789626	-146.29576	Closed low scrub	Salpul(80), Betnan(20), Alncri(5), Vaculi(20), Empnig(10), Corcan(3), Spibea(3), Valcap(1), Petfri(3), F	Alpine Wet Low Scrub	Salipulc–Calacana
V33.09	08/18/98	63.788313	-146.29993	Closed low scrub	Betnan(60), Vaculi(10), Ledpal(20), Carbig(10), Hylspl(70)	Alpine Wet Low Scrub	Betunana–Vacculig
V33.12	08/18/98	63.790241	-146.315512	Open Low Scrub	Vaculi(40), Carbig(20), Ledpal(15), Empnig(15), Lichens(10)	Alpine Wet Low Scrub	Betunana–Vacculig
V33.14	08/18/98	63.792962	-146.3172	Mesic graminoid herbaceous	Erivag(20), Vaculi(30), Betnan(10), Ledpal(15), Empnig(5), Thamn(2), Claran(2), Sphag(20), Cetcuc(	Alpine Wet Tussock Meadow	Eriovagi–Empenigr
V33.14a	08/18/98	63.79525	-146.311	Closed low scrub	Salpul(30), Betnan(60), Vaculi, Empnig(20)	Alpine Wet Low Scrub	Betunana–Vacculig
V33.14b	08/18/98	63.79635	-146.308	Mesic graminoid herbaceous	Tussocks w Thamnolia	Alpine Wet Tussock Meadow	Eriovagi–Empenigr
V33.22	08/18/98	63.805448	-146.33217	Open Low Scrub	Vaculi(20), Carbig(10), Salpul(10), DryOct(5), Betnan(10)	Alpine Wet Low Scrub	Betunana–Vacculig
V33.23	08/18/98	63.78482	-146.254	Open Low Scrub	Salpul(20), Betnan(20), Carbig(10), Salret, Thamn(3), Hiealp(1), Fesalt(1)	Alpine Wet Low Scrub	Betunana–Vacculig
V33.25	08/18/98	63.7903	-146.271	Closed low scrub	Salpul(70), Betnan(10), Artemisia(15), Corcan(5), Empnig(10), Fesalt(5)	Alpine Wet Low Scrub	Salipulc–Calacana
V33.26	08/18/98	63.78957	-146.27	Closed Tall Scrub	Alncris(60)Salpul(30), Calcan(10), Petfri(5), Lycsel(5), Linbor, Carbig, vaculi	Alpine Rocky Moist and Wet Low and Tall Sc	Alnucris–Calacana
V33.28	08/18/98	63.79378	-146.273	Closed low scrub	Betnan(30), Vaculi(20), Ledpal(20), Petfrig(5),Carbig (5), Erivag(5), Equissylv (3), Sphag (10)	Alpine Wet Low Scrub	Betunana–Vacculig
V33.29	08/18/98	63.79737	-146.271	Open Dwarf Tree Scrub	Picmar(40), Betnan(20), carbig (30), Vacculig (20), Ledpalus (10)	Lowland Wet Needleleaf Forest	Picemari–Ledugroe
V34.09	08/18/98	63.732034	-146.053207	Fireweed/Festuca	Festuca(15),Epiang(10), Ceratodon(70), Salgla(3),Seedlings:Betpap(tr), Poptrem(tr), Popbals,(tr), Pic	Upland Moist Low and Tall Scrub disturbed	Epilangu–Cerapurp
V34.11	08/18/98	63.733878	-146.069377	Fireweed/ Open Paper Birch	Betpap seedl+sapl.(30), Epiang(30), Calcan(10), Rubidae(5),Polalas(5),Polyt(40),	Upland Moist Low and Tall Scrub disturbed	Betupapy–Calacana
V34.12	08/18/98	63.730594	-146.065563	Open Dwarf Black Spruce Forest	Picmar(30),Ledgro(15),Calcan(10),Carbig(10), Lich(15), Alncri(5),Salspp(8), Vacc ulig(20),Vavi (15) F	Lowland Wet Needleleaf Forest	Picemari–Ledugroe
V34.13	08/18/98	63.728444	-146.062398	Open Dwarf Black Spruce Forest	Picmar(30), Ledgro(20), Arcuva(5), Feathermoss(70), Vaculi(15), Betnan(8), Chamadaph(5), Carbig(	Lowland Wet Needleleaf Forest	Picemari–Ledugroe
V34.14	08/18/98	63.726943	-146.058819	Open Black Spruce Forest	Picmar(50), Feathermoss(95), Ledgro(5), Carbig(10), calamag(5), Petasites(1), Vacul;l(5), Vacvit(5)	Lowland Wet Needleleaf Forest	Picemari–Ledugroe
V34.15	08/18/98	63.725856	-146.058757	Open Dwarf Black Spruce Forest	Picmar(35), Carbig(15), Calcan(5), Vaculi(10),ledgro(15), Feathermoss (60), Lichens(15), Salspp(5),S	Lowland Wet Needleleaf Forest	Picemari–Ledugroe
V34.16	08/18/98	63.72455	-146.065174	Woodland Dwarf Black Spruce	Picmar(8), Carbig(25), Erivag(5), Vaculi(20),Betnan(8)Salapp(8),alncri(8), Feathermoss(60),Vacvit(10	Lowland Wet Low Scrub	Betunana–Vacculig
V34.17	08/18/98	63.722607	-146.06715	Woodland Black Spruce (Marginal Dwarf)	Picmar(15), Alncri(10), Salspp(8), Ledgro(20), Betnan(8). Vaculi(20),Carbig(10), Equisil(20)	Lowland Wet Low Scrub	Picemari–Ledugroe
V34.21	08/18/98	63.71627	-146.097	Closed Mesic Shrub birch-Vaculig	Vaculi(55), Betnan(40), Ledgro(30), Vacvit(20), Cetcuc(5), Hylspl(50), Salgla(5)	Upland Moist Low and Tall Scrub disturbed	Betunana–Vacculig
V34.23	08/18/98	63.714812	-146.090415	Open Dwarf Black Spruce Forest	Picmar dwarf(35), ledgro(8), Vaculi(20), Salspp(8),Carbig(15), Erivag(2), Alncri(8), Empnig(10), Sphag	Lowland Wet Low Scrub	Picemari–Ledugroe
V35.02	08/21/98	63.860571	-145.607116	Low Scrub/ Fireweed	Polyalask(2),CarBruessc*(2), Calspp(10),Salspp,Betnan(5),Epiang(10), Vacculi(5),Polytric(10),Equiar	Upland Moist Low and Tall Scrub disturbed	Epilangu–Cerapurp
V35.03	08/21/98	63.859623	-145.605162	Open Mesic Shrub Birch-Ericacaeous Shrub	Vaculi(10), Ledum(15), Betnan(5),Polytric(15), Arctag(10), Equsil(10), Epiang(5),Bareground(15)	Upland Moist Low and Tall Scrub disturbed	Vacculig–Polytric
V35.05	08/21/98	63.862364	-145.585956	Open Mesic Shrub Birch	Vaculi(30), Ledgro(15), Betnan(5), Polyt(15), Arctag(10), Equsil(10),Epiang(5)	Upland Moist Low and Tall Scrub disturbed	Vacculig–Polytric
V35.06	08/21/98	63.863514	-145.584739	Open Mesic Shrub Birch-Ericacaeous Shrub	Betnan(20),Rosaci(2), Arclat(25), Epiang(5), Equarv(30), Ceratodon(15), Bare Soil(10)	Upland Moist Low and Tall Scrub disturbed	Epilangu–Cerapurp
V35.09	08/21/98	63.8562	-145.573414	Closed Low Shrub Birch	Betnan(70), Salgla(5), Salarb(2), Vaculi(20), Ledgro(10), Arclat(2), Hylspl(5)	Upland Moist Low and Tall Scrub disturbed	Betunana–Vacculig
V35.10	08/21/98	63.854173	-145.575307	Open Aspen Saplings	Poptre grazed saplings(35), Arcuva(20), Bare ground (15) , Ceratodon(15), Vacvit(5), Epiang (5), Fes	Upland Moist Low and Tall Scrub disturbed	Poputrem–Arctuva-
V35.13b	08/21/98	63.8476	-145.595	Open Aspen Saplings	Poptre grazed Saplings (30), Arcuva(5), Vaculi(3), Picmar Seedl. (tr)	Upland Rocky Dry Low Scrub	Poputrem–Arctuva-
V36.02	08/26/98	63.893941	-145.763501	Open Black Spruce Forest	Picmar(50),Stereo(30),Ledumspp(5),Feathermoss(55)Lichens(10), Vacvit(15), Empnig(10)	Lowland Gravelly Needleleaf Forest	Picemari–Ledugroe
V36.03	08/26/98	63.892259	-145.761892	Open Black Spruce Forest	Picmar(35), Stereo(30), Feathermoss(40), Vacvit(20), Poptrem(dwarfs-2), Betnan(5), Ledum(2)	Lowland Gravelly Needleleaf Forest	Picemari–Ledugroe
V36.04	08/26/98	63.892644	-145.758089	Arcto-Lichen?	Stereo(60), Leddec(30), Betnan(20), Vaculig(5), Arctuva(5), Poptre dwarf((<.5m)5), Cetrspp(15)	Lowland Gravelly Moist Low Scrub	Betunana–Stereoca
V36.05	08/26/98	63.890665	-145.754286	Woodland Black Spruce	Poptrem<.5m)(35), Picmar(10), Stereo(55), Cetrspp(10), Leddec(25), Vacculi(5), Louispro(tr),Festsp(	Lowland Gravelly Moist Low Scrub	Poputrem–Stereoca
V36.10	08/26/98	63.883832	-145.755916	Woodland Black Spruce	Picmar(10), Betnan(25), Stereo(30), Arcuva(5), Vacvit(15), Vaculi(10), Cetrspp(10), Poptre dwarf(5)	Lowland Gravelly Moist Low Scrub	Betunana–Stereoca
V36.11	08/26/98	63.885456	-145.761522	Open Black Spruce Forestr	Picmar(30), Stereo(60), Cladste(10), Lichens(15), Betnan(25), Vaculi(10), Leddec(3), Vacvit910)	Lowland Gravelly Needleleaf Forest	Betunana–Stereoca
V36.12	08/26/98	63.890339	-145.76362	Woodland Black Spruce	Picmar(20), Ster(65), Cladste(10), lichens(15),Betnan(25), Vaculi(10), Leddec(3), Vacvit(10)	Lowland Gravelly Needleleaf Forest	Betunana–Stereoca
V40.01	08/25/98	63.792438	-145.818823	Closed Dwarf Aspen	Poptrem(70), Vibedu(2), Vacculi(25), Vacvit(15)Corcan(5), Ledgro(5), Calcan(5), Fesspp(1), Rosaci(3	Lowland Wet Broadleaf Forest	Poputrem–Arctuva-
V40.04	08/25/98	63.788133	-145.815906	Closed Alder Willow Tall	Alncri(40), Salpla(40), Calcan(25),Cornus (10), Angelica(1), Petasites(1)	Lowland Moist Tall Scrub	Alnucris–Calacana
V40.05	08/25/98	63.786528	-145.814856	Open Shrub Birch	Betnan(55), Salgla(5), Empnig(25), Lichens(20), Mosses (40), Arctagrostis(5), Carbig(10), Salret(5)	Lowland Gravelly Moist Low Scrub	Betunana–Vacculig
V40.06	08/25/98	63.784338	-145.815651	Open Scrub Birch	Betnan(50), Carbig (20), Lichens (Stereo=2,total=10)Salpul(2), Fest(5), Mosses(40), Petasites(5)	Lowland Wet Low Scrub	Betunana–Vacculig
V40.07	08/25/98	63.784187	-145.817538	Open Scrub Birch	Betnan(65), Salgla(5), Carbig(20), Arclat(5), Wat(2), Leddec (10), Hylspl(30), Petasites(5), Lichens(1(	Lowland Wet Low Scrub	Betunana–Vacculig
V40.09	08/25/98	63.788312	-145.818153	Open Shrub Birch	Betnan(50), Alncri(1), Lichens(25), Mosses(40), Leddec(20), Vaculi(15), Carbig(15), Salgla(3)	Lowland Wet Low Scrub	Betunana–Vacculig
V40.10	08/25/98	63.791463	-145.821764	Closed Tall Alder	Alncri(75), Epiang(10), Vaculi(5), Calcan(5), Festuca(5), Poagla(1), Poaspp(1), Salgla(5), Betnan(5)	Lowland Moist Tall Scrub	Alnucris–Calacana
V41.13	08/28/98	63.801497	-145.754125	Open Dwarf Aspen	Poptre dwarf(30), Stereocaul (40),, Betnan(50),Vacvit(20),Arcrub(15),Rhytid(5), Cetrspp(10)	Lowland Gravelly Moist Low Scrub	Betunana–Stereoca
V41.14	08/28/98	63.802233	-145.751888	Upland Low Scrub	Poptre dwarf(5), Stereo(25), Betnan(45), Cetrspp(15), Vacvit(25), Leddec (5), Rhytid(5)	Lowland Gravelly Moist Low Scrub	Betunana–Stereoca
V41.15	08/28/98	63.801233	-145.750792	Woodland White Spruce-Aspen	Poptre Dwarf(15), Picgla(8), Poltri(20), Hylspl(50),Vacvit(25), Betnan(60), Salgla(10),Cornus can(5),S	Lowland Gravelly Moist Low Scrub	Betunana–Vacculig
V41.16	08/28/98	63.800167	-145.749889	Open Dwarf Aspen	Poptre dwarf(40), Betnana(50), Picgla(10), Salplani(5), Vacvit(25), Vaculi(10), Hylspl(45), Stereo(2), L	Lowland Gravelly Moist Low Scrub	Poputrem–Stereoca
V43.07	08/19/98	63.72483	-145.976	Open White Spruce Forest	Picgla(35), Popbal(1), Hylspl(85), Astrag(2), Vacvit(5), Geocaul(2), Arcalp(2), Solcan(2)	Riverine Gravelly Needleleaf Forest	Piceglau–Popubals–Shepcana
V43.10	08/19/98	63.722333	-145.972269	Open Black Spruce Forest	Picmar(25), Betpap(10), Betnan(15), Ledgro(50), Sphagnum&Feathermoss, (70),Vaculig(10)	Lowland Wet Needleleaf Forest	Picemari–Ledugroe
V43.11	08/19/98	63.71933	-145.971	Open White Spruce Forest	Picgla(30),Alnus(35), Calcan(20), Geocaul(10), Boschniakia(tr), Feathermosses(70)	Upland Moist Needleleaf Forest	Piceglau–Alnucris
V43.15	08/19/98	63.70882	-145.97	Needleleaf Woodland	Picgla(15), Ledgro(20, Vaculi(30), Vacvit(5), Empnig(5), Rubcha(5), Carbig(5), Hylspl(30)	Lowland Wet Needleleaf Forest	Piceglau–Alnucris
V43.16	08/19/98	63.70802	-145.968	Open White Spruce Forest	Picgla(35), Hylspll(80), Calcan(15), Rosaci(5), Vibedu(5)	Upland Moist Needleleaf Forest	Piceglau–Alnucris

Table C1. Omission and commission errors used to approximate the accuracy associated with mapping of ecotypes (37 classes) on Fort Greely, Alaska, 1999.

	Mapped Ecotype																																					
Ground Plot Ecotype	38211	38090	38843	38832	30632	30633	30640	38031	30631	50433	50431	51458	50442	40652	58832	58642	58031	50641	50432	59042	79640	70640	78842	70633	70632	78832	70631	70431	78851	118890	118843	118642	110442	110458	40220	139090	139040	Total
Upper Perennial River (38211)	1	1																														2						4
Riverine Gravelly Barrens (38090)	1	3	1																																			5
Riverine Gravelly Dry Dwarf Scrub (38843)		1	2																																			3
Riverine Gravelly Dry Broadleaf Forest (38832)			1	3																																		4
Riverine Moist Broadleaf Forest (30632)				5	1																																	6
Riverine Moist Mixed Forest (30633)				4		1	1	4	2				2																									14
Riverine Moist Low and Tall Scrub (30640)																																						0
Riverine Gravelly Needleleaf Forest (38031)								4																														4
Riverine Moist Needleleaf Forest (30631)							1	4	1		1																											7
Lowland Wet Mixed Forest (50433)										5	3																											8
Lowland Wet Needleleaf Forest (50431)								3			22	2	4				1			1		1		1			1					1						37
Lowland Tussock Scrub Bog (51458)							1				1	19	6																									27
Lowland Wet Low Scrub (50442)											1	14	13			1					1												1					31
Lacustrine Moist Meadow (40652)							1					1									1														1			4
Lowland Gravelly Dry Broadleaf Forest (58832)															1		1																					2
Lowland Gravelly Moist Low Scrub (58642)																11																						11
Lowland Gravelly Needleleaf Forest (58031)											1					1	8																					10
Lowland Moist Tall Scrub (50641)													2					2			1	1																6
Lowland Wet Broadleaf Forest (50432)					1					1									1			2																5
Lowland Low Scrub - disturbed (59042)												1	1								2	1																5
Upland Moist Low and Tall Scrub - disturbed (79640)												1								6	6																	13
Upland Moist Low and Tall Scrub (70640)													1			1						4		1	2	1	1											11
Upland Rocky Dry Low Scrub (78842)													1			1					1	6	2															11
Upland Moist Mixed Forest (70633)																								1	1	1												3
Upland Moist Broadleaf Forest (70632)				1																				1	10	1	1											14
Upland Rocky Dry Broadleaf Forest (78832)												2								1	1	1		4	2		1											12
Upland Moist Needleleaf Forest (70631)																	1							2			3											6
Upland Wet Needleleaf Forest (70431)											2																2											4
Upland Rocky Dry Meadow (78851)									1												1								1									3
Alpine Rocky Dry Barrens (118890)																														4	2	1						7
Alpine Rocky Dry Dwarf Scrub (118843)																														2	7		1					10
Alpine Rocky Moist Low Scrub (118642)																					1	1										7	5	1				15
Alpine Wet Low Scrub (110442)																																9	7	6				22
Alpine Wet Tussock Meadow (110458)																																1		6				7
Ponds and Lakes (40220)																1																						1
Human Barrens (139090)																																						0
Human Disturbed Scrub (139040)																																						0
Total	2	5	4	13	2	1	4	15	4	6	31	40	30	0	1	16	11	2	1	8	15	17	2	10	15	3	9	0	1	6	9	21	14	13	1	0	0	332

APPENDIX D: AGGREGATION AND SIMPLIFICATION OF ECOTYPE CLASSIFICATION

Table D1. Method for consolidating 37 ecotype classes into 20 aggregated ecotypes.

Aggregated ecotype	*Ecotype*
Alpine Barrens	Alpine Rocky Dry Barrens
Alpine Dwarf Scrub	Alpine Rocky Dry Dwarf Scrub
Alpine Low Scrub	Alpine Rocky Moist Low Scrub
	Alpine Wet Low Scrub
Alpine Tussock Meadow	Alpine Wet Tussock Meadow
Upland Low and Tall Scrub	Upland Rocky Dry Meadow
	Upland Rocky Dry Low Scrub
	Upland Moist Low and Tall Scrub
	Upland Moist Low and Tall Scrub—disturbed
Upland Broadleaf Forest	Upland Rocky Dry Broadleaf Forest
	Upland Moist Broadleaf Forest
	Upland Moist Mixed Forest
Upland Needleleaf Forest	Upland Moist Needleleaf Forest
	Upland Wet Needleleaf Forest
Lowland Low Scrub	Lowland Gravelly Moist Low Scrub
	Lowland Low Scrub - disturbed
	Lowland Wet Low Scrub
	Lowland Tussock Scrub Bog
	Lacustrine Moist Meadow
Lowland Tall Scrub	Lowland Moist Tall Scrub
Lowland Broadleaf Forest	Lowland Gravelly Dry Broadleaf Forest
	Lowland Wet Broadleaf Forest
Lowland Mixed Forest	Lowland Wet Mixed Forest
Lowland Needleleaf Forest	Lowland Gravelly Needleleaf Forest
	Lowland Wet Needleleaf Forest
Ponds and Lakes	Ponds and Lakes
Riverine Barrens	Riverine Gravelly Barrens
Riverine Dwarf Scrub	Riverine Gravelly Dry Dwarf Scrub
Riverine Low and Tall Scrub	Riverine Moist Low and Tall Scrub
Riverine Broadleaf Forest	Riverine Gravelly Dry Broadleaf Forest
	Riverine Moist Broadleaf Forest
Riverine Needleleaf Forest	Riverine Gravelly Needleleaf Forest
	Riverine Moist Mixed Forest
	Riverine Moist Needleleaf Forest
Upper Perennial River	Upper Perennial River
Human Disturbed	Human Disturbed Barrens
	Human Disturbed Scrub

Table D2. Areal extents of aggregated ecotypes found within Fort Greely.

	Area	
Aggregated ecotype	*ha*	*%*
Alpine Barrens	3,378	1.3
Alpine Dwarf Scrub	2,659	1.0
Alpine Low Scrub	18,710	7.2
Alpine Tussock Meadow	6,698	2.6
Upland Low and Tall Scrub	24,507	9.4
Upland Broadleaf Forest	11,216	4.3
Upland Needleleaf Forest	12,911	5.0
Lowland Low Scrub	107,081	41.1
Lowland Tall Scrub	865	0.3
Lowland Broadleaf Forest	1,932	0.7
Lowland Mixed Forest	2,021	0.8
Lowland Needleleaf Forest	35,863	13.8
Ponds and Lakes	3,044	1.2
Riverine Barrens	4,876	1.9
Riverine Dwarf Scrub	1,899	0.7
Riverine Low and Tall Scrub	1,263	0.5
Riverine Broadleaf Forest	4,179	1.6
Riverine Needleleaf Forest	7,355	2.8
Upper Perennial River	8,106	3.1
Human Disturbed	1,672	0.6
Total	260,234	100

Table D3. Omission and commission errors used to approximate the accuracy associated with mapping of aggregated ecotypes (20 classes) on Fort Greely.

	Mapped Aggregated Ecotype																				
Ground Plot Aggregated Ecotype	Upper Perennial River	Riverine Barrens	Riverine Dwarf Scrub	Riverine Broadleaf Forest	Riverine Low and Tall Scrub	Riverine Needleleaf Forest	Lowland Mixed Forest	Lowland Needleleaf Forest	Lowland Low Scrub	Lowland Broadleaf Forest	Lowland Tall Scrub	Upland Low and Tall Scrub	Upland Broadleaf Forest	Upland Needleleaf Forest	Alpine Barrens	Alpine Dwarf Scrub	Alpine Low Scrub	Alpine Tussock Meadow	Ponds and Lakes	Human Disturbed	Total
Upper Perennial River	1	1															2				4
Riverine Barrens	1	3	1																		5
Riverine Dwarf Scrub		1	2																		3
Riverine Broadleaf Forest			1	9																	10
Riverine Low and Tall Scrub																					0
Riverine Needleleaf Forest				4	2	16		1	2												25
Lowland Mixed Forest							5	3													8
Lowland Needleleaf Forest						3		32	8			1	1	1			1				47
Lowland Low Scrub					2			2	67			5					1		1		78
Lowland Broadleaf Forest				1			1	1		2		2									7
Lowland Tall Scrub									2		2	2									6
Upland Low and Tall Scrub						1			11			21	4	1							38
Upland Broadleaf Forest				1					3			2	21	2							29
Upland Needleleaf Forest								3					2	5							10
Alpine Barrens															4	2	1				7
Alpine Dwarf Scrub															2	7	1				10
Alpine Low Scrub												2					28	7			37
Alpine Tussock Meadow																	1	6			7
Ponds and Lakes									1												1
Human Disturbed																					0
Total	2	5	4	15	4	20	6	42	94	2	2	35	28	9	6	9	35	13	1	0	332